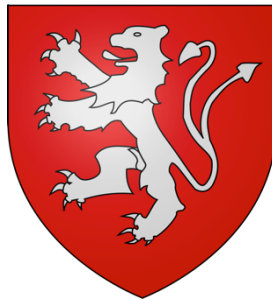


**Sustainable ('grass-roots') approach to
Oral Health Promotion
Utilising Established NGO and Rural
Community Groups**



Tracey Lennemann RDH, BA

**School of Pharmacy
Department of Health and Life Sciences
De Montfort University**

**This dissertation is submitted for the degree of Doctor of Philosophy
in
Dental Education Research and Global Oral Health**

September 2017

For my Family and Friends

***Never underestimate the power of your mind
and what you can do with it.***

Thank you for believing in me.

“Give a man a fish and you feed him for a day.

Teach a man to fish and you feed him for a lifetime.”

Chinese Proverb

Declaration

This dissertation is the result of my own work and includes nothing, which is the outcome of work done in collaboration except where specifically indicated in the text. It has not been previously submitted, in part or whole, to any University or Institution for any degree, diploma, or other qualification.

This thesis in accordance with the School of Pharmacy, Department of Health and Life Sciences post-graduate guidelines of De Montfort University.

Competing Interests and Funding:

I declare there have been no conflicts of interest.

This study was self-funded. Various dental companies and private dental practitioners donated all required materials. Logistics, the organization of village volunteers, participants of the local NGO staff, and local village groups in India were provided by Karunya Trust, under KinderNotHilfe (KNH) support and sponsorship. KNH provided funding for internal travel, accommodation and translators. The clinical team comprised of volunteer members of the charity, Dental Hygienists for India (DHFI). DHFI volunteers and the research team provided funding for their own flights and visas.

Signed: _____

Date: _____

**Tracey Lennemann RDH, BA
London, UK**

Acknowledgements

I wish to thank everyone who donated valuable knowledge, time, and dedication contributing to this research.

My deepest gratitude goes to Mrs. Carole Brennan, my friend and co-founder of DHFI, who volunteered her time, energy, and knowledge to this project over the past 4 years. I could have not done it without you.

Mr. Guido Falkenberg, from KNH (KinderNotHilfe), who believed in DHFI from the beginning, without his support in letting us cooperate with KNH's partners in India (HCDI & Karunya Trust), none of this research would have been possible.

The team from Karunya Trust; Catholic Charities in India, Father Paul, Sister Edith, Sister Shaila, Sr. Alfonse and others, delivered amazing organisational skills, logistical support and freshly cooked food throughout the past 4 years. Thank you for making us feel at home.

The CFCD team, working with the Ambernath Tribal Project, I truly admire the work you do within the communities and the endless hours of service you dedicate for helping these people. You are a motivated team whom I am proud to know and work with.

Dental Hygienists and Therapists for India (DHFI), thank you for volunteering your time to join us on this study and for offering your services for the children, lending dental instruments and materials for screenings and returning for follow-up treatments.

Thank you to my support team at home: To my parents, for encouraging me to always go after my dreams. To my partner, Arun Velautham, thanks for your wise input, feedback, and support all these years. You have kept me grounded. And to Dr. Dana Flavin, thanks for keeping me “scientifically” thinking and focused.

Finally, to my supervisors: Prof. Martin Grootveld, thank you for accepting me as your student and believing that I could do this and putting up with my many insistent emails and phone calls for your knowledgeable guidance, and to my second supervisor, Prof. Robin Henager-Greene, I am so grateful for your mentorship and being my accountability partner and keeping me on track with my writing. You both have taught me skills and knowledge that I never thought was possible.

Words cannot express my gratitude enough to each and every one of you. Thank you!



Summary / Abstract

The purpose of this research was to examine potential sustainable delivery methods for Oral Health Promotion (OHP) in developing populations in India, utilising non-dental rural community development groups, specifically those led by Non-Governmental Organizations (NGO) involved in community development. The focus of this research was based on a longitudinal cohort study experimental design for exploratory purposes conducted over a period of one year, using a randomised cluster sampling of community developmental projects within the rural-tribal villages of Ambarnath, Maharashtra, India. The study was measured in 4 phases: oral health knowledge of village parents through a questionnaire, dental screenings of children, and integration of a 'train-the-trainer' type of Oral Health Awareness Programme (OHAP) for three test groups, followed by one-year comparison follow-up data. Findings show evidence of comprehension and dissemination of the information in the OHAP course. Screening data also showed a reduction in decay in primary and permanent teeth in the children, after one year, and a positive change in oral hygiene behaviours. The collaboration and utilisation of non-dental NGO teams and local participatory groups from a 'grass-roots' level was proven to be effective for disseminating information and activities for oral health awareness and promotional programmes within these populations. Evidence supports a collaboration of these groups can be recommended for introducing a structured and understandable oral health programme utilising non-dental NGO and local participatory groups.

Keywords: oral health promotion, oral disease prevention, NGO, community development, community-based groups, dental awareness, dental disease in rural communities, oral health mind-sets, underserved populations, grass-roots

Contents

Dedication	4
Acknowledgments	5
Abstract	7
List of Tables	13
List of Figures	14
List of Abbreviations and Acronyms.....	17
<u>1. Introduction</u>	18
1.1 Oral Health Perspectives	18
1.2 Objectives	20
1.3 Aims	21
<u>2. Literature Review</u>.....	23
2.1 Overview of Oral Diseases	23
2.1.1 The Progression of Oral Care	28
2.1.2 Dental Care Access in Developed Populations	29
2.1.3 Populations in Poverty.....	30
2.1.4 Oral Disease in Underserved Communities	31
2.1.5 Lack of Local Dental Professionals	33
2.1.6 School-Based Oral Health Programmes.....	34
2.1.7 Requirements for Oral Health Programmes	36
2.1.8 NGO Influence and Partnership	37
2.2 Relationship Building and Observational Needs Assessment.....	39
2.2.1 Data Sampling.....	44

2.2.2 Ethical Approval and Good Clinical Practice	53
2.2.3 Pre-Study Observations	54
2.2.4 Requirement for Comprehensive Research.....	60
 3. Materials and Methods	61
3.1 Study Experimental Design for Exploratory Purposes	61
3.2 Study Population	65
3.2.1 Questionnaires and Screening Participants	65
3.2.2 OHAP Test Groups	70
3.3 Contents of Study	71
3.3.1 Phase 1 (Questionnaire)	71
3.3.2 Phase 2 (Baseline Data)	74
3.3.3 Phase 3 (Oral Health Awareness Program) (OHAP)	75
3.3.3.1 Training Team	75
3.3.3.2 Educational Test Groups	75
3.3.3.3 Oral Health Awareness Course (OHAP)	75
3.3.3.4 Course Goals	81
3.3.3.5 Course Implementation	81
3.3.3.6 Course Objectives	87
3.3.4 Phase 4 (One-year Baseline Data and Follow-up).....	87
3.3.4.1 Drop-out	88
3.3.4.2 Statistical Analysis of Questionnaire and Dental Screening.....	90
3.3.4.3 Multivariate PCA of Experimental Dataset	91

4. Results Arising from Questionnaire Assessments	92
4.1 Questionnaire Participation	92
4.2 Questionnaire Analysis	93
4.2.1 Analysis of Question 2: Importance of Children’s Teeth	93
4.2.2 Analysis of Question 4: Frequency of Cleaning Children’s Teeth	94
4.2.3 Analysis of Question 5: Tongue Cleaning vs. Teeth Cleaning	95
4.2.4 Analysis of Question 10: Interest to Learn about Children’s Teeth	96
4.2.5 Analysis of Question 13: Everyday needs: Food, Shelter, Family	97
4.2.6 Analysis of Question 14: Sweets vs. Children’s Teeth	98
 5. Results Arising from Dental Screening Evaluations	 99
5.1 Baseline Screening Data 2014	99
5.1.1 Analysis of Screening for Presence of Oral Disease 2014	99
5.2 Baseline Screening Data 2015	102
5.2.1 Analysis of Screening for Visible Decay of Primary & Permanent Teeth 2015.....	102
5.3 Presence of Visible Calculus 2014 and 2015.....	104
5.4 Comparison of Screening Date from 2014 & 2015	107
5.4.1 Percent Decay Variance between Primary & Permanent Molars 2014-2015.....	107
5.5 Mean Average of Decay per Child from 2014-2015	108
5.6 Comparisons per Village	109
5.6.1 Visible Decay Changes in Primary Teeth 2014 to 2015.....	110
5.6.2 Visible Decay Changes in Permanent Teeth 2014 to 2015	111
5.6.3 Visible Decay Changes in Primary (d,e’s) Molars 2014 to 2015.....	112
5.6.4 Visible Decay Changes in Permanent (6’s) Molars 2014 to 2015	113
5.7 Visible Calculus Change from 2014 & 2015	114

6. Results Detailed Univariate and Multivariate Evaluations of the

Oral Health Screening Datasets 116

6.1 Univariate Evaluations using an Analysis-of-Covariance (ANCOVA) Model116

6.2 Permutation Analysis.....126

6.2.1 Permutation Analysis performed via (P-RDA).....126

6.3 Principal Component Analysis (PCA)131

6.3.1 PCA Eigenvalues of 8 Screening Variables132

6.3.2 PCA Loading Plots of 8 Screening Variables.....133

6.3.3 PCA Loading Plots of 5 Main Screening Variables.....136

7. Discussion.....139

7.1 Questionnaire Evaluation140

7.1.1 Analysis Question 2: Importance of Children's Teeth.....141

7.1.2 Analysis Question 4: Frequency of Cleaning Children's Teeth.....142

7.1.3 Analysis Question 5: Tongue Cleaning vs. Teeth Cleaning.....143

7.1.4 Analysis Question 10: Interest to Learn about Children's Teeth144

7.1.5 Analysis Question 13: Everyday Needs: Food, Shelter, Family145

7.1.6 Analysis Question 14: Sweets vs. Children's Teeth.....145

7.1.7 Questionnaire Limitations and Suggestions147

7.2 Evaluations of Dental Screenings149

7.2.1 Analysis of Dental Decay 2014-2015149

7.2.2 Analysis of Visible Calculus 2014-2015150

7.3 Comparisons Between the Villages Involved in the Study.....151

7.3.1 Influence of Village Location and Access151

7.3.2 Livelihoods and Sources of Income151

7.3.3 Comparisons per Village of Tooth Decay Changes 2014-2015153

7.3.4 Strengths and Limitations of Baseline Screenings155

7.4 Oral Health Awareness Programme Evaluation	156
7.4.1 Comparisons of the ETG	160
7.4.2 Strengths, Limitations and Suggestions of Test Groups	162
7.4.3 Strengths, Limitations and Suggestions of WSHG	162
7.4.4 Strengths, Limitations and Suggestions of CP.....	165
7.4.5 Suggested Improvements to the management of the OHAP course.....	166
7.5 Limitation and Suggestions of NGO-CFCD	167
7.6 Community Development Issues, Concerns and Challenges.....	167
7.6.1 NGO Involvement Outcomes.....	167
7.6.2 Durability, Sustainability and continued OHAP.....	169
7.6.3 Community Development Transformation and Challenges	171
7.7 Suggestions and Recommendations for Future OHAP with NGOs	173
7.7.1 Future Research Recommendations.....	175
7.8 Impact of Study and Future Recommendations.....	176
7.8.1 Financial Impact.....	177
7.8.2 Partnerships and Collaborations	179
 8. Concluding Comments	 181
 9. References.....	 183
 Appendix	 193
Appendix 1a Ethical Approval Document.....	193
Appendix 1b Consent form for parents of children participating in this study.....	194
Appendix 1c Participant Information Sheet for this study.....	195
Appendix 2 Raw data and % Responses for Questionnaire Questions.....	196
Appendix 3 Dental Decay Screening Data.....	197
Appendix 4 Comparisons of dental disease changes per village 2014 to 2015.....	198
Appendix 5 OHAP Course developed by Tracey Lennemann.....	199

List of Tables

3. Methods and Materials

Table 3.1	Numbers of parents per village, participating in questionnaires during Phase 1 and Phase 4 of this study plus additional questionnaires....	69
Table 3.2	Numbers of children per village screened during Phase 1 and Phase 4 of this study including non-compliant and non-returning.....	70
Table 3.3	Reasons for drop out of dental screenings for Phase 4 in 2015.	89

5. Results Arising from Dental Screening Evaluations

Table 5.1	Analysis of mean, standard deviation, and percentage totals of oral disease 2014.....	99
Table 5.2	Analysis of mean, standard deviation, and percentage totals of visible decay in 2015.	102
Table 5.3	Comparisons per village of the overall % of oral disease reductions.....	109

6. Results Detailed Univariate and Multivariate Evaluations of the Oral Health Screening Datasets

Table 6.1	ANCOVA Table: Variable of primary teeth decayed	118
Table 6.2	ANCOA Table: Variable of retained & decayed primary teeth.....	119
Table 6.3	ANCOVA Table: Variable of permanent teeth decayed	120
Table 6.4	ANCOVA Table: Variable of primary molar decayed.....	121
Table 6.5	ANCOVA Table: Variable of permanent molar teeth decayed.....	122
Table 6.6	ANCOVA Table: Variable of mixed dentition	123
Table 6.7	ANCOVA Table: Variable of missing teeth	124
Table 6.8	ANCOVA Table: Variable of visible calculus	125
Table 6.9	Permutation Test of screenings (2014 vs 2015).....	127
Table 6.10	Permutation Test of villages (2014 vs 2015).....	128
Table 6.11	Permutation Test of ages (2014 vs 2015).	129
Table 6.12	Permutation Test of child participant (2014 vs 2015).	130
Table 6.13	PCA Eigenvalue factors of overall screening data.....	132
Table 6.14	PCA Loading plot of 8 screening variables	133
Table 6.15	PCA eigenvalues of 5 major variables	136
Table 6.16	Percent contributions of variables after Varimax rotation.....	137
Table 6.17	Squared cosines of the variables after Varimax rotation	137

7. Discussion

Table 7.1	Source: Karunya Trust Statistics on Ambernath Tribal Village	152
	livelihoods and intervention targets.	

List of Figures

2. Literature Review

Figure 2.1	Example of visible decay and erosion on lateral front teeth.....	47
Figure 2.2	Example of decay in primary second molar teeth (Nr. d and e).....	48
Figure 2.3	Example of visible decayed and retained primary front teeth	49
Figure 2.4	Example of decay in primary second molar and retained primary first molar	50
Figure 2.5	Examples of active gum disease with tooth loss.	51
Figure 2.6	Visible brown stain and yellow calculus in 5-year-old child.	52
Figure 2.7	Example of a local village shop with a big bag of hard sweets	55
Figure 2.8	Example of available sweets inside local village shop	57
Figure 2.9	Example of crowding & retained primary teeth, two rows of teeth.	58
Figure 2.10	Examples of retained teeth creating two rows of teeth effect	59

3. Methods and Materials

Figure 3.1	Map of the Ambernath area of Karunya Trust Tribal Villages	67
Figure 3.2	Karunya Trust Community Development Projects of Ambernath Tribal region and corresponding project numbers.....	68
Figure 3.3	(a) and (b), Oral Health Questionnaires pages 1 and 2.....	73
Figure 3.4	Photograph of the OHAP in progress for the WSHG.....	77
Figure 3.5	Photograph showing the local interpreter explaining OHAP	78
Figure 3.6	Photograph showing OHET demonstrating effective toothbrushing Techniques	79
Figure 3.7	Photograph of interactive brushing practice for all participants.....	80
Figure 3.8	Photograph of the WSHG group delivering OHAP to parents	82
Figure 3.9	CP group giving OHAP to Chon village parents with NGO team	83
Figure 3.10	Photograph of CP trainers giving toothbrushing instructions to Chon Village	85
Figure 3.11	Photograph of Chon village children practicing toothbrushing with an ETG.....	86

4. Results Arising from Questionnaire Assessments

Figure 4.1	Bar diagram showing responses (%) of question 2 in 2014-2015.....	93
Figure 4.2	Bar diagram showing responses (%) to question 4 in 2014-2015.....	94
Figure 4.3	Bar diagram showing responses (%) to question 5 in 2014-2015.....	95
Figure 4.4	Bar diagram showing responses (%) to question 10 in 2014-2015.....	96
Figure 4.5	Bar diagram showing responses (%) to question 13 in 2014-2015.....	97
Figure 4.6	Bar diagram showing responses (%) to question 14 in 2014-2015.....	98

5. Results Arising from Dental Screening Evaluations

Figure 5.1	(a) Histogram showing the frequency of visible decay in primary and permanent teeth in 2014; (b) Cumulative frequency plot of visible decay in primary and permanent teeth in 2014; (c) Normalised cumulative density plot of visible decay in primary and permanent teeth in 2014	100
Figure 5.2	(a) Histogram showing frequency of total teeth with visible decay in primary and permanent teeth in 2015. (b) Cumulative Frequency plot of total teeth with visible decay in the primary and permanent categories in 2015. (c) Normalised Cumulative density plot of total teeth with visible decay in both primary and permanent teeth in 2015.	102
Figure 5.3	(a) Histogram showing the frequencies of the visible presence of calculus in 2014 and 2015; (b) Cumulative frequency plot of visible calculus in 2014 and 2015; (c) Normalized cumulative density plot of visible calculus in 2014 and 2015.	104
Figure 5.4	Bar diagram showing % change in the mean decay of primary and permanent teeth from 2014 to 2015.	107
Figure 5.5	Bar diagram showing mean average per child of tooth decay in primary and permanent teeth from 2014 to 2015.	108
Figure 5.6	Individual Village percentage changes of visible decay seen in primary teeth from 2014 to 2015.	110
Figure 5.7	Individual Village percent changes of visible decay seen in permanent teeth from 2014 to 2015.	111
Figure 5.8	Percentage changes per village in primary molars (d,e's) from 2014 to 2015.	112
Figure 5.9	Percent change in permanent first molar (6's) per village from 2014-2015	113
Figure 5.10	(a) Percent change in visible calculus per village from 2014 and 2015 (b) Overall mean percentage change in visible calculus per village from 2014 to 2015.	114

6. Results Detailed Univariate and Multivariate Evaluations of the Oral Health Screening Datasets

Figure 6.1	Plot of mean+95% confidence intervals (CIs) for the primary teeth scores found at the 2014(before) and 2015(after) oral health assessment screening periods	118
Figure 6.2	Plot of mean+95% confidence intervals (CIs) for the permanent teeth scores found at the 2014(before) and 2015(after) oral health assessment screening periods	120
Figure 6.3	Plot of mean+95% confidence intervals (CIs) for the primary molars scores found at the 2014(before) and 2015(after) oral health assessment screening periods	121
Figure 6.4	Plot of mean+95% confidence intervals (CIs) for the permanent molar scores found at the 2014(before) and 2015(after) oral health assessment screening periods	122
Figure 6.5	Plot of mean+95% confidence intervals (CIs) for the missing teeth scores found at the 2014(before) and 2015(after) oral health assessment screening periods	124
Figure 6.6	Histogram of permutations of screenings 2015 vs 2014	127
Figure 6.7	Histogram of permutations of villages 2015 vs 2014	128
Figure 6.8	Histogram of permutations of ages 2015 vs 2014	129
Figure 6.9	Histogram of permutations of child participant 2015 vs 2014	130
Figure 6.10	PCA Scree Plot of 8 variables	132
Figure 6.11	PCA loading plot of 8 screening variables	134
Figure 6.12	Scree plot of eigenvalue of 5 PCs isolated	136

List of Abbreviations and Acronyms

OHP: Oral Health Promotion
NGO: Non-Governmental Organization
WHSG: Women Self Help Group
CPG: Childrens' Parliament Group
WHO: World Health Organization
PDL: Periodontal Ligament
VSCs: Volatile Sulphur Compounds
GDP: Gross Domestic Product
EHCP: Essential Health Care Programme
STH: Soil-transmitted helminthes
KNH: KinderNotHilfe (Children in Need, a German NGO)
CCCYC: Churches Council of Child and Youth Care
CSI: Church of South India
HQ: CCCYC Headquarters
DHFI: Dental Hygienists for India (UK based Charity)
HCDI: Holistic Child Development India
CFCD: Community Focused Child Development
PRA: Participatory Rural Appraisal
TPB: Theory of Planned Behaviour
OHAP: Oral Hygiene Awareness Programme
ETG: Experimental Test Groups
OHET: Oral Health Education Team
ECC: Early Childhood Caries
FDI: World Dental Federation
CBO: Community Based Organisation
CBI: Central Bureau of Investigation
FCRA: Foreign Contribution Regulations Act in India

1. Introduction

1.1 Oral Health Perspectives

It is said that the eyes are the windows to the soul, as well it can be said that the mouth is the door to the body.

Years of evidence-based research and observation have linked oral disease to systemic conditions. These have shown the importance of regular oral hygiene for maintaining healthy teeth and gums, not only from a dental perspective, but also from a medical perspective. Yet, in many countries, millions of adults and children are unaware of the importance of proper oral hygiene and many may not even own a toothbrush. Resources for dental care and oral health education remain limited, especially in developing countries. Particularly vulnerable are children, as primary teeth are more susceptible to decay. When dental services are available, they can be very costly and unattainable for most underserved populations. The importance of dental care tends to be realised as a last priority and is predominately sought out once pain occurs. By this time, dental disease can be in the advanced stages and might lead to further oral problems including abscesses, advanced pain and tooth loss.

The past decades of research has shown that dental disease is mostly preventable, especially in the primary dentition. Therefore, awareness, education, and prevention should begin at a young age. Hence, programmes have been devised for oral health

promotion and dental screenings in schools and other public facilities within developing communities throughout the world. Utilisation and delivery of such programmes have been carried out using dental professionals from a “top down” approach with varied results. There is, however, only limited availability of research data currently available in the area of oral health promotion for rural communities at a local ‘grass-roots level,’ i.e. utilising non-dental personnel, local groups and community leaders, as resources who potentially exert a direct influence on the development of communities. Involving these groups in an oral health awareness programme may give rise to changing perspectives, mind-sets, improved daily oral health habits, and increase the wants and needs of parents and local organizers towards the importance of oral health. This in turn, could generate an improved motivational action in caring for the oral health of their children and decrease the onset of dental decay within these populations.

From the available studies, which have been implemented within school settings, dental professionals were utilised for screening, oral care instruction, and fluoride applications. When dental disease and problems were found and treatment recommended, written information regarding the examination results and dental condition were passed onto the caregiver or parent advising them to seek complementary treatment for their children. Yet, only a small percentage of parents returned to obtain free services. It would appear that parents seemed to lack the necessary information concerning valid reasons and requirements for having their children treated, and therefore mistakenly seemed to believe that it is not important

because the “baby teeth” will fall out anyway. Not understanding the importance of such actions, and the possible negative outcomes arising therefrom, might tend to lead to limited motivational changes in oral health perspectives and practices.¹⁻⁵

1.2 Objective

There are many programmes, schemes, and published reports outlining concepts for promoting an improved level of oral health awareness in various countries, many utilising dental professionals, dental students, and dental hospitals in school-based programmes. However, these can be costly, lacking personnel and necessary funding for the training required, as well as for the implementation of such programmes.¹⁻⁵

The purpose of this research is to examine potential successful sustainable delivery methods for Oral Health Promotion (OHP) for children using longitudinal data from non-dental rural community groups in India, specifically those led by Non-Governmental Organizations (NGO) community development projects supported by charitable groups. These data provide information on factors associated with effective dissemination of information for dental awareness and disease prevention in underserved populations. The approach studied here, implementing a community-based participatory process⁶, may prove to be a less costly delivery system and sustainable method for much required dental care and awareness in rural communities.

1.3 Aims

Reaching beyond traditional means of school-based programmes and costly governmental schemes, a 'grass-roots' approach to oral health promotion and activities involving non-dental, NGO teams could be much more effective. These teams have already built relationships with local populations and have established groups such as; Women's Self-Help Groups (WSHGs), Children's' Parliament Groups (CPGs), health advisors/workers, local volunteers, teachers and community leaders, which represent a viable alternative.

It could be possible to teach simple and basic dental knowledge and oral care skills-sets to promote oral health awareness and prevention within local peer groups, which might exert an additional influence for motivational change, as opposed to the traditional delivery method using primarily dental professionals and a "top-down" approach.

In principle, it could also provide a sustainable and cost effective means for the delivery of oral health awareness incorporating local beliefs, customs, and mind-sets along with environmental challenges. Positive long-term outcomes would provide recognition of early visible dental disease, introduce prevention plans that are feasible and fundable, and also create programmes and practices for developing rural community-based programmes that would influence large numbers of parents and children.

Charities and volunteer groups of dentists, dental hygienists, dental therapists, and dental nurses seeking to provide dental services and oral health awareness education to underserved populations will benefit from the findings of this research. Moreover, already established NGO programmes could integrate these results and methods into medical and dental awareness projects using locally based professionals and volunteers supporting community development.

In addition, this research could provide Ministries of Health, who are in need of affordable sources of health educators, an alternative source of local teachers, mentors, and advisors. Researchers might find this interesting for future development and ideas utilising community-based approaches in research for study in this and other areas. Consequently, this process could give rise to an increased level of dental awareness, the promotion of oral healthcare, a motivational change in oral health practices, and eventually a reduction in the progression of oral diseases amongst these community children.

2. Literature Review

2.1 Overview of Oral Diseases

The World Health Organization (WHO) 2012 fact sheet published that over 5 billion people suffer from oral diseases.⁷ Studies have shown that the degrees of dental disease vary between industrialised countries and countries still in development. Modern advancements in oral disease prevention and health promotion have helped wealthier countries reduce dental decay in children by means of access to dental preventative measures, such as fluoride, prophylaxis, and dental hygiene products. Yet, globally, in areas of low-income, high poverty, where there can be an excess of malnutrition or changing nutritional sources, higher levels of alcohol consumption, increased tobacco use, and lower educational levels, the opposite is occurring, and dental disease is increasing. Even in Western countries, these areas and populations with compromised immune functions are seeing higher dental problems. More importantly, in these communities, it is found that up to 90% of the disease goes untreated.⁷⁻⁹ When oral disease is left untreated, it increasingly progresses to advanced and severe stages of the condition resulting in high levels of pain, discomfort, infection, and eventually tooth loss. These conditions can have social, nutritional, and health consequences.⁷⁻⁹

The two main dental infections are tooth decay (caries) and periodontal (gum) disease. Both diseases are activated through various species of oral bacterial plaque otherwise known as biofilms. Each disease is comprised of a different group of bacterial

pathogens, which are the underpinnings of each condition working together with various other factors.^{10,11} However, the two bacterial groups do not have influence on the other infection, yet a person can have both diseases simultaneously. In other words, each dental disease is a separate condition and needs to be treated as such. Other prevalent oral diseases and conditions found are oral cancers, tooth loss, dental erosion, and developmental defects in the enamel.

Dental decay effects the actual tooth and begins when bacterial plaque is left on the tooth for longer periods of time, through the lack of oral hygiene such as tooth brushing and interdental cleaning. Continuous consumption of food sources with high sugar contents; natural or “free sugars”, exacerbate the acids produced by the bacteria, triggering the decay process. This begins as a “white spot” in the enamel and can progress throughout the entire tooth if not quickly treated and stopped.^{10,12,13}

Decay breaks down the thin enamel layer covering the tooth and if not treated, it can spread into the softer dentinal layers and eventually into the pulp chamber that contains the tooth nerve. This can create sensitivity and pain, especially in primary teeth, as the pulp chamber is larger and the enamel layer thinner. In view of this, children are more susceptible to higher amounts of decay at faster rates than adults. If not treated, this can progress further creating an abscess causing extreme pain, as the tooth could be dying and in need for a root canal treatment to relieve the pain and save the tooth. If not treated, extreme pain, facial swelling, and tooth loss could occur.^{13,14}

Current worldwide research has reported that high levels of dental decay are affecting children under the age of 15. Adults and children alike in low-income and less educated populations also tend to have elevated levels of caries. Newly formed and erupted teeth are at higher risk levels for decay in children; hence early detection is crucial to the arresting of the decay. New initial decay in adults has been associated with non-communicable diseases such as diabetes, high blood pressure, and stroke, and asthma, with most decay occurring on cervical margins of teeth or around already placed dental materials, such as crowns, and fillings.¹⁵

In underserved populations with limited or no access to dental services, high decay rates can have an affect on quality of life. Untreated decay in adults can lead to tooth loss, malnutrition, reduced immune systems, aesthetic embarrassment, lack of social interaction, withdrawnness, and other oral conditions and diseases.¹⁶⁻¹⁷ Research has shown that children, who suffer from high amounts of decay, tend to withdraw from social interaction with other children, have higher absentee school days and less participation in school activities, due to excruciating pain. A completely decayed and broken down, “bombed out” primary molar with pulpal involvement can hinder the developmental process of the permanent molar underneath, which can lead to a disturbance of developing teeth or missing teeth in general. Missing teeth can lead to embarrassment and reduced oral function such as talking, eating, and smiling. High levels of dental decay in young children can compromise immune functions and have also been proven to impede growth, and increase malnutrition, due to limited chewing

function. High levels of pathogenic oral bacteria and pain have also been seen associated with high levels of decay, among these groups.¹⁷⁻²²

Periodontal (gum) disease is the second of the two dental diseases and affects the bone and surrounding tissues holding the tooth in place. Contributing factors to periodontal disease are accumulations of various species of bacterial plaque, left on teeth and tissues over time creating hard deposits (calculus), together with poor oral hygiene, generating an inflammatory response in the tissue.

Dental Calculus arises from the mineralisation and hardening of soft plaque bacteria. These bacterial colonies adhere together forming a 'pellicle', which is softer than fully mineralized calculus, and firmer than 'biofilms'. Biofilms are comprised of communes of various species of bacteria, colonising together to further form and grow. These biofilms are comprised of gram-positive and gram-negative charged bacterial pathogens. It is these pathogens within the biofilm, which initiate and promote the progression of dental disease.²³⁻²⁸ When these bacterial groups are in balance and removed daily, via effective oral care, the mouth will remain healthy and function correctly. The longer these soft plaque bacterial deposits remain on the teeth, the harder they become. Once these deposits are formed, they are firm, rough, unsightly, and serve as a perfect harbouring ground for the new formation of soft biofilms and plaque. If these biofilms are not removed through daily oral hygiene practices, or bi-annually via professional prophylaxis treatment, they can initiate an inflammatory response of swelling, redness, and bleeding of the gums, and gingivitis occurs.^{27,28}

Further progression into suppuration (pus), halitosis, destruction of bone and tissues, mobility, and tooth migration can be observed without pain. Predominantly, pain will first be recognised after the advanced stages of infection and bone loss have occurred, taking into account that each person has a different pain threshold level. Further influencers are smoking, tobacco, alcohol, and links to inflammatory systemic conditions such as; diabetes, cardiac disease, and rheumatoid arthritis.^{11,29-35}

Onset of periodontal disease is mostly diagnosed in adults, but has been seen in younger populations and the tendency is increasing in these age groups. Increased stress, lifestyle, smoking, and poor nutrition could be influencing factors in within the younger generations, but needs to be further researched.³¹

This progression is especially important to prevent in adolescent and young adults, since the bacteria can spread quickly and exacerbate the oral disease process. Non-treated gingivitis can progress to the destruction of the periodontal ligament (PDL), which holds the tooth to the bone. As the disease progresses, it will lead to the further destruction of supporting tissues surrounding the teeth. As this process continues over a lifetime, it will lead to continued recession of the tissues, increasingly deeper pockets as a result of the infection under the gums, continued bone loss, loose and migrating teeth resulting in wider spaces between the teeth, advanced bad breath, severe pain, and eventually tooth loss.³⁶⁻³⁹ The prevalence of periodontal disease is extremely frequent in vulnerable populations with limited or no access to dental care, and can exert a direct influence on their general health, as previously noted.⁴⁰⁻⁴²

In young children, newly-formed supragingival (above the gum) calculus (tartar), is softer and easier to remove than it is in adults, since it is still during the formation stage.^{37-39,43} Daily toothbrushing and the use of fluoride toothpaste can lessen the build-up of plaque, food debris, and newly-forming biofilms, hence reducing the formation of dental calculus.^{38,44-46} Once these deposits are removed, it will facilitate reduction of the inflammatory process associated with gingivitis, and also eliminate the toxic volatile sulphur compounds (VSCs) associated with halitosis, which is a common by-product of active periodontal disease.⁴⁷ These VSCs have also been shown to be linked to the periodontal bacteria which advance the breakdown of the supporting tissues surround the teeth. High amounts of VSCs can increase the rate of destruction, and therefore, elimination of VSCs can aid in the improvement of oral health.⁴⁸

2.1.1 The Progression of Oral Care

The importance of oral care has been dated back to early Egyptian times when the first documented “dentist” was discovered around 2600 BC. Civilisations used fingers, sticks and twigs from trees and plants, quills, bones, and various other sources for teeth cleaning. Not until the 1600’s were the first forms of a “toothbrush” found in the combination of a bamboo stick affix with boar bristles.^{49,50} Today, we have a plethora of oral hygiene products available including specialised toothpastes, interdental brushes, picks, flosses, fluorides, varnishes, rinses, and gels. These materials have been proven to aid in the reduction of oral bacteria and plaque, hence supporting the prevention of dental disease, and orientated towards the possibility of eradicating

dental decay.^{51,52} Yet, we still see some of these ancient practices today in rural socio-economic challenged communities who do not have access to modern dental services.

In some regions of India, the use of a stick of a tree, such as a Neem stick, (branch from a Neem tree), or another twig of a local tree or plant, broken off into a 7- 10 cm length piece, the bark peeled away from the end, and chewed to make the stick 'fray' open, into a form of a round brush, is the most common form of a toothbrush.

According to the ancient and traditional customs of Charaka Samhita, Ayurveda Practices, this is chewed for the medicinal properties of the tree or plant for digestive juices, and also to combat foul smells, and then scraped over the teeth, in view of bacterial reduction for better taste and breathing. However, in poorer rural regions, children tend to use their finger with ground up brick, or charcoal powder, or salt, rubbing it over the teeth for a few seconds.⁵³⁻⁵⁵

Many of these children are not encouraged to clean their teeth, as parents are unaware of the importance of such practices and do not deem as necessary.^{49,50}

Yet, many of these villages have shops that provide nylon toothbrushes and fluoride tooth powder, so access to oral care products does exist, it remains a matter of awareness, importance, and priorities.

2.1.2 Dental Care Access in Developed Populations

Industrialised countries have public health resources with budgets allotting 5-10% for public dental care and promotion.^{7,8} Access to dental services and education is

widespread and readily available through public and private funding. The past 100 years have shown a decrease in dental decay in children through public oral health projects run by dental professionals and volunteers, school-based projects, topical and water fluoridation programmes, and a general access to public dental facilities.

However, decay rates in poorer, lower socio-economic populations, less educated, and those with changing nutritional sources still tend to be high. Tooth loss in adults within these populations also tends to be higher as the cost for dental treatment is beyond their means. Therefore, often, to relieve pain, teeth will be extracted instead of treated.⁷ The research is showing an increase in adult periodontal disease and in some communities, an increase in decay in children in view of modern lifestyles, changing nutritional sources, and/or malnutrition.^{7,56,57} This confirms prevention of dental disease is still an on-going challenge in most countries, whether industrialised or developing.

2.1.3 Populations in Poverty

The United Nations released the "2015 Revision of the World Population Prospects" in which they raised their previous global demographic projections and now estimate that the world population has reached 7.5 Billion. Demographic experts estimate populations of India will overtake China by 2028, a development that could increase the world population to 9.6 billion, rendering India the most inhabited country on this planet.⁵⁷⁻⁵⁹ As the population increases, the access to healthcare and more importantly, the awareness and prevention of disease be greatly needed.

Examination of the overall age deviation of the population, according to the India Census Report of 2011, approximately 30% of India's population is 14 years old and under, with 65% between the ages of 15- 64.⁵⁸⁻⁶⁰ A recent report from the World Bank has now shown a decrease from an estimate of 42% in 2011 to 12.7% of the world population living just at or under the poverty level of \$1.90/day.⁶¹ Over 70% of the population in India resides in rural area with limited access to healthcare.^{62,63}

2.1.4 Oral Disease in Underserved Communities

Although the above statistic appears to demonstrate a positive effect on the reduction of poverty in these population groups, dental disease is on the rise, and is markedly influenced by the introduction and easy access of Western products and diet, including tobacco, alcohol, sweets, and sugary drinks. The two main dental diseases are tooth decay and periodontal disease. The statistics show these types of dental decay, which can lead to major pain and discomfort, represent 60–90% of school children and a high amount of adults. Severe periodontal disease, often resulting in tooth loss, is reported in 15–20% of middle-aged (35-44 years) adults visiting a dentist, and globally, about 30% of people aged 65–74 have no natural teeth.^{63,64} To date, a large amount of the world population do not visit dentists regularly nor have access to dental facilities, and cannot afford to pay for dental treatment. Hence, statistics could be much greater than recorded. None the less, globally, the need for improved oral care and preventative measures is a worthwhile health issue and greatly needed.

For years, researchers have been providing data on the associations of underserved populations in developing countries, showing high levels of oral disease.^{61,63,64}

Oral diseases, primary decay, and periodontitis (but also including malocclusion and oral cancer), play a significant role in general health, quality of life, and childhood development as previously discussed. Indeed, direct links to systemic diseases and oral conditions have been demonstrated in various studies.⁴⁴ Childhood decay and adult edentulism show correlations to early tooth decay, tooth loss, and malnutrition.⁶³⁻⁶⁷ Undernourishment, including vitamin deficiencies in socially- and economically-challenged communities have also contributed to oral diseases, and in some cases, death ascribable to poor oral health has occurred.^{63,68-71}

Recent studies in various rural areas in India have also shown a prevalence of decay, which ranges from 40-80%.⁷²⁻⁷⁵ This in itself shows a much greater requirement for oral health awareness and preventative education to commence at an early age, on all social and economic levels. With a rapidly- increasing population, India has no specific separate allocation for an oral health budget as the country has assigned only 4.9 % of the gross domestic product (GDP) for general health-related expenditures, which is declining in some states and territories in India.⁷⁶ Together with the lack of a budget for oral health promotion and education, between in the year 2000-2010 period, India has instead promoted an increase in dental students in view of a forecasted shortage of dentists, and had an increased opening of private dental institutions. However, future projections estimate a decrease of enrolment attributable to oversaturation of the private market, high competition, a geographic imbalance of dentist to patient

ratios in cities, and a lack of dental auxiliaries.^{76,77} However, there is still a lack of access to dental providers and facilities for poorer communities, in rural areas.

2.1.5 Lack of Local Dental Professionals

To date, in a country with over a billion people, India has no registered dental nurses or chair-side assistants, no denturists, and only 3,000 registered dental hygienists, and 5,000 laboratory technicians with the majority located in major cities. From 40 available schools for auxiliaries in 1990, there are now only an estimated 20 schools available for such auxiliary training in India compared to 185 private and governmental dental schools. Hence, dentists are overburdened and have had no increase in their overall efficacies.^{76,77}

Currently, there are an estimated 300 dental schools in India, with most of the graduates choosing to work in more urban areas. Statistics show 90% of the dentists and dental facilities are located within urban areas, whereas, only 30% of the population lives. Only, 10% of dentists are available in the countryside where 70% of the population resides and are in greater need of dental care. Dental facilities are extremely limited and those that exist can be impossible for underserved communities to access. Also, new dental graduates tend to choose to work in the cities, as it is more desirable and profitable than in rural areas. Governmental guidelines have suggested recruiting future dental students from these lesser-served areas in hopes that they will return to their communities to provide public dental facilities. Yet, there is no guarantee and return on investment could be low.⁵⁸⁻⁶³

The need for comprehensive healthcare, which is based on improved dental education, skilled workers, and an overall prevention plan, will present an even greater concern as the population grows. Therefore, alternative measures need to be taken in order to address these increasing essentials of oral healthcare promotion, education, and oral disease prevention within rural populations.

2.1.6 School-Based Oral Health Programmes

In general, we are aware that daily brushing with fluoride toothpaste has been reported to bring a 30% reduction of decay when implemented through 2-3 year school-based programmes,^{1,2} and toothbrushing teeth twice a day can reduce dental disease by 50 %.⁷⁸ With this in mind, numerous school-based programmes have been designed, implemented, and tested throughout various countries and various socio-economic communities worldwide, with varying results. Integrated within a school health programme, the Essential Health Care Programme (EHCP) based in the Philippines implemented in 2010, started an on-going programme of larger context of official developmental assistance which links Philippino and European Universities. They have introduced a 3-part concept for personal hygiene; hand washing, deworming, and daily tooth brushing with fluoride toothpaste. One-year results have shown positive evidence for improvement in soil-transmitted helminthes (STH), yet, within the first year of the programme, only a slight decrease in dental decay and oral infections have been observed. Researchers, however, are anticipating decay and infections will decrease significantly more in time.² Additional school-oriented studies have shown conflicting results, i.e. that oral screenings of children can improve the

relevance of oral health sufficiently enough to motivate parents to take their children to a dentist for treatment,³ while others have shown that when free treatment is offered within the local area, only 30% of parents actually seek such treatment for their children.⁴

This low percentage of parents seeking complementary treatment may be ascribable to logistics, ease of travel to a dental facility, (especially for rural populations), or a lack of knowledge regarding the importance of primary teeth. Many parents believe that the primary, “baby” teeth are not important since they will just ‘fall out’ eventually, and if the child does not have pain, then all is well. Many rural myths, cultural beliefs, and attitudes influence early preventative care of pre-school children, along with investing time and money for travel to a clinic. Even if free treatment is offered, dental health appears unimportant to many in these populations. Many people, in most countries, view dental clinicians as someone to see only if a tooth, were to generate pain, severe or otherwise. Surveys confirm that rural populations value oral hygiene only as a low priority and do not view dentists as “real” doctors. Recognition and respect of dentists are at lower comparable levels than to equivalent medical clinicians. Therefore, motivation remains low for oral care unless pain is involved.^{5,79,80}

Increasing populations, decreases in oral healthcare providers, limited budgets or unavailable funding, and increased evidence between links of systemic and oral diseases, are pushing India in the direction of alternative delivery methods for oral healthcare promotion to meet dental health and decay prevention requirements.

2.1.7 Requirements for Oral Health Programmes

A recent publication by J.G. Rogers (2011), “Evidence-based oral health promotion resource”, outlines gaps in evidence-based publications.⁸⁰ It directly suggests, “involving areas such as: active community development approaches for sustainable oral health promotion, oral health literacy training programmes and evaluation measures, together with improvements in the quality of the design and methodology of interventions, longer-term, participatory, community-based and focused programmes, and assessment of longer-term outcomes of interventions, and a range of appropriate outcomes and process measures”, as areas which need to be improved upon and researched further.^{80,81}

In 2008, the WHO reported that, “the need is still high for the adjustment of programs and the development of oral health programs with strong efforts that should be made towards the implementation of prevention and health promotion”.⁸¹ In 2001, the Dental Caries Task Group also reported that, “both community and individual interventions require tailoring in order to achieve a more equal and person-centred preventive focus, and therefore reduce any social gradient in health”.⁸² Within that overall scope, priorities include the evaluation and assessment of “public health interventions delivering oral health promotion activity linked to general health promotion efforts”.⁸²

2.1.8 NGO Influence and Partnership

The WHO Global Oral Health Program has offered support and partnership for NGOs and National health leaders becoming involved in such programmes. Partnerships involving local NGOs could be a viable alternative for OHP as training structures, teams, and leadership has already been established within a community development project.

According to recent reports from the Indian Central Bureau of Investigation, it is estimated that 31,000 NGOs exist in India today.⁸³ Rural community development encompasses such vital issues for sustainability including, safe drinking water, environment and land development, livelihoods, children's rights and protection, education, nutrition, women's rights and protection, empowerment, women's self help groups and leadership, sanitation, and health. These local organisations have invested years in creating strong relationships with underserved communities within their areas. Acceptance and trust have been established along with proven systems and programmes for such projects. OHP programmes could be integrated into already recognised concepts, thus providing an alternative delivery source for OHP. Therefore, a 'grass-roots' approach to oral health education and awareness, together with simple oral health programmes and activities involving NGO projects, local charities, and caregivers, women and children groups, local leaders, and other influencers of children's health serves as the focus of this thesis. It will observe interactions between local poorer populations and NGO teams and determine if such OHP courses could be successfully implemented via these groups.

It will also determine if OHP could be accepted and adapted into local cultural habits via mind-set changes through education and information. It will establish if such a programme could be sustainable after one year. And lastly, it will focus on the effects of the OHP and reducing visible decay and early signs of periodontal disease in children together with methods of creating community awareness and motivational changes for improved oral hygiene, focusing on a preventative orientation rather than a treatment for repair.

A foundation for this study was created using an initial examination of rural communities in India. The needs assessment outcomes, as well as how the relationship to the NGO and study population began are discussed in the next sub-section prior to developing methods for the current study.

2.2 Relationship Building and Observational Needs Assessment

In January 2010, a unique opportunity arose for the performance of dental charity work with children from impoverished backgrounds in India. The contact was through a group of German dentists, Zahnärzte für India (translated as Dentists for India). Today it is known as German Dental Carehood International e.V. This was a self-supported volunteer group of dentists who travelled to India and offered treatment for the underserved populations who were in the developmental programmes of the German NGO, KinderNotHilfe (KNH), (translated as Supporting Children in Need).

KNH is funded by donations, and supports over 100,000 children in various regions of India, as well as serving children in 28 countries worldwide. The children supported by KNH are from the poorest families who live under the poverty level, and are most in need of help, according to KNH guidelines. Day Care Centres were provided for children ranging 1-12 years of age. Hostels (school-homes for boys and girls separately) were provided for children aged 8-20 (if still studying), and rural community clusters comprising of 10-20 rural villages encompassing over 800-1000 children within each cluster were also receiving educational programmes for the development and improvement of life for these populations.

KNH partners with local NGO's. The Churches Council of Child and Youth Care (CCCYC) was the local partner at that time in southern India, which has since been superseded

by the current organization of Church of South India (CSI). Their headquarters in India are based in Bangalore, which has projects in the following southern Indian States of Andhra Pradesh, Kerala, Karnataka and Tamil Nadu.

A colleague from the UK and I were the first Dental Hygienists to visit such projects and programmes. The concept of prevention of dental diseases and general oral hygiene was not generally understood nor was it a topic of focus within the NGO developmental programmes for underserved populations. However, it did not take the Chief Executive Officer (CEO) of CCCYC long to realize the value of our programme.

The CEO of CCCYC was disillusioned by dentists who had visited before, since he received no feedback on patients being seen, processes used, project outcomes, and most importantly, if the children were being properly screened and treated under their care. Learning that dental hygiene is a profession of education, prevention, and maintenance of oral health, he requested us to observe what was being conducted, what could be changed and improved, and report back our findings.

We spent one week at Rainy CSI Mission Hospital, in Chennai, and one week at Scudder Memorial Mission Hospital in Ranipet, working with the local dentists and hospital staff, and visiting the rural day care centres and hostels within each region. It took only a couple of days to determine the demand for a simple structured concept for oral health awareness. For example, we drove a seven hour round trip to visit a day care centre of 50 children who had already been screened by the visiting dentists three

months previously. It was obvious, these children required treatment, not screenings every three months. Also, during the screenings, it was noticed that the caretakers of these children could be taught how to recognise dental disease, and also how to prevent these problems through the instructions of correct oral hygiene, ultimately limiting the amount of time and money involved in such care.

The findings from this experience solidified the requirement to reach out and to educate those working with the children of these populations. Upon hearing our findings, we were invited to return in May 2010 and present an oral health awareness programme for the teachers of the boy's and girl's schools and homes (hostels), and for the crèche nurses of the day care centres. An original Oral Health Awareness Training Programme was created specifically for the benefit of the children, and also to fulfil a need of these underserved populations.

We returned again in February 2011 to provide a course of training for the day care crèche nurses, social workers and child minders from each facility in the state of Andhra Pradesh who were unfortunately absent during the 2010 programme.

The day course comprised both theory and practice. The progression of the two dental diseases were taught, as well as the aetiology of each disease, their systemic links, and how to recognize such dental diseases in children. The importance of taking care of the primary dentition was emphasized, and the requirement to see a dentist or a hygienist was recommended, although this option is often unavailable to poorer populations;

moreover, dental treatments can often be expensive. Dental decay is preventable, and gum disease controllable, and therefore, the nurses, social workers, and child minders were taught how to screen a child for dental disease and instruct them on proper brushing techniques. Participants from each facility were provided with an action plan to implement within their facilities. Together with the implementation of daily brushing programmes for the children, it was recommended that each year, around 1 September (the beginning of the school year), that each facility leader screen the children and send a report to CCCYC Headquarters (HQ). Around 200 individuals partook in the training programme, and all yearly reports from 2011 to 2014 were to be sent back to us for monitoring once received by HQ.

The training was enthusiastically received, and in November 2011, the next development phase of the programme was created, together with a follow-up and analysis of the training programme, and treatment for the children. For this purpose, we organized twelve volunteer Dental Hygienists from England and Canada to visit the CCCYC projects of Andhra Pradesh, the poorest of the four states and least supported by the visiting dentists. Subsequently, the charity Dental Hygienists for India (DHFI) was created. This is a non-profit group of dental professionals, mainly dental hygienists and therapists, working in co-operation and officially partnered with KNH.

The following year (November 2012), another group was sent to Andhra Pradesh to the projects that were not observed in 2011. Additionally, other non-supported

projects were visited, screened, treated, and educated in January 2014 and January 2015 when our teams visited various facilities throughout southern India.

Six groups of two volunteers carried out the following duties:

1. Screening for decay, calculus, inflammation (swollen & bleeding gums), crowding, abnormalities, etc.
2. Determining which children required immediate treatment by a dentist.
3. Performing simple, basic remote Ultrasonic scaling/Hand scaling.
4. Teaching brushing to all children and childcare workers.
5. Controlling and optimising oral healthcare programs at facilities.
6. Supervising the implementation of daily brushing routines with older children and caregivers.
7. Networking and assisting local dentists at mission hospitals (when applicable and requested).

In addition, the following were implemented in January 2014 and January 2015:

1. Dental Therapists joined the team for the treatment of simple extractions, fillings, and repair of decay.
2. Oral health awareness programmes available for community projects involving the above 7 duties, whilst adding educational value for parents, community centre leaders, teachers, and local social workers.

3. Introduction of oral health awareness programmes for community developmental projects for Holistic Child Development India (HCDI) in Northern India.

Within 5 years, we screened, treated, and educated over 50,000 children. Materials and toothbrushes were donated with support from various dental companies, along with the purchase of products through fund raising.

The success of the oral health awareness programme showed not only an overwhelming interest in the subject matter, but also a level of trust and acceptance of the training team, which is the most important aspect for working with these populations, and also for executing such an important programme. This trust level and ease of comprehension and application of the programme became increasingly evident within the needs assessment of this project.

The next approach was to explore and assess children in rural community projects, and also determine if the levels of oral disease were similar to the school settings (and therefore in need of care). The needs assessment is explained in the next section.

2.2.1. Data Sampling

A cross-sectional trial was used for determining the need for an oral health programme in developing communities in rural India. This trial studied the extent of dental and oral disease present, and to which measures and challenges are to be

expected, when designing an oral health awareness programme. A pre-study information gathering assessment was initiated in December 2012 over a one-week period in the region of Costal Andhra, located in the state of Andhra Pradesh, India. The region is primarily a farming community and consists of tribal community groups similar to the main study groups.

All data were collected from individual villages under the developmental programmes KNH, within a tier supported cluster project. Assessments were completed during daylight hours from 9-3 pm in 18 out of 20 rural villages of Costal Andhra. Two villages were not assessed, as the children would be returning home from school after 5 pm when it was too dark to screen, and mosquito counts were high.

The sample size was 552 children (53% boys and 47% girls) from Community-Focused Child Development (CFCD) project supported by KNH. The children were screened according to the WHO Oral Health Assessment Form 2012 for Children and in accordance with the WHO Oral Health Survey Guidelines, 5th edition.⁸⁴

Dental disease and conditions were detected as presented in the following figures. Visible signs of decay were found in the primary dentition of a 5-year-old child in the form of black teeth with erosion on neighbouring teeth, similar to 'nursing bottle caries syndrome', decay of upper front primary teeth due to fluids with high sugar content such as fruit juices, milk, and sugary drinks.⁸⁵

Parents reported that children drink “sugar tea” before bed and prolonged breast feeding can also attribute to such decay Figure 2.1 Permanent (adult) first molars with beginning decay (white spots), and advanced lesions in the second primary molars were common as seen in this 7-year-old child Figure 2.2

Common problems of retained and decayed primary front teeth with lagging eruption of permanent front incisors plus further decay of posterior (back) teeth were noted in a 6 year-old child in Figure 2.3. Visible decay in primary second molar with retained primary first molar tilted lingual (towards tongue) and erupting first permanent pre-molar erupting outwards towards the buccal (cheek side), seen in a 12-year-old child Figure 2.4. An example of active gum disease with signs of visible hard calculus (dental tarter), and soft plaque presents in Figure 2.5. Gingival inflammation is present between the teeth showing puffiness and swelling. The first permanent incisor is also missing in this 14-year-old child. Visible brown stain and yellow calculus (dental tartar) seen in a 5-year-old child in Figure 2.6.



Figure 2.1. Example of visible decay (black) on primary front teeth know as ‘nursing caries’ (decay) in a 5-year-old child, and erosion (orange-brown) on lateral front teeth.



Figure 2.2. Example of decay in primary second molar teeth and beginning decay lesions (white spots) in first permanent molars (6's) in a 7-year-old child.



Figure 2.3. Example of visible decayed and retained primary front teeth with eruption of permanent incisor in 6-year-old child. Additional decay and break down in remaining teeth on the child's left side.



Figure 2.4. Example of decay in primary second molar and retained primary first molar tilted lingual (towards tongue) with erupting first permanent pre-molar leaning towards the buccal (cheek side) in an 12-year-old child.



Figure 2.5. Examples of active gum disease with tooth loss. Visible hard calculus (brown and yellow), soft plaque, and gingival inflammation between teeth with puffiness, swelling, and missing first permanent incisor in a 14-year-old child.



Figure 2.6. Visible brown stain and yellow calculus in 5-year-old child.

Subsequent to data collection, a toothbrush and toothpaste (donated by Colgate-Palmolive Company) were provided to each child followed by group toothbrushing instructions and practice. Instructions were given via a local dentist and visiting dental professionals, and eventually via CFCD staff. Adults, including mothers, grandparents, and community leaders were present and involved in the pre-trial.

2.2.2 Ethical Approval and Good Clinical Practice

All parents of participating children signed permission forms, as well as verbal/written (email) permission from KNH and CFCD to perform the screenings.

Two calibrated dental professionals using visible observations of dental conditions, using sterile gloves and a sterile mouth mirror, screened the children. A ball-ended CPI periodontal probe was used for assessing decay, gingival inflammation assessment and calculus. Only visible decay that was soft was recorded. Gloves were replaced for every child, and masks with magnifying loupes were worn. A local dentist was present as a scribe for recording the oral assessment findings and translations. The local CFCD team professionally organized children in each village and also provided instruction translations. Radiographs were not taken since decay classifications were not the object of this study. Consent forms and data lists were taken during the needs assessment period and repeated again for Phase 1. Ethical approval for the pre-assessment and study was obtained and approved by De Montfort University's Faculty of Health and Life Sciences Human Research Ethics Committee [Appendix 1(a)].

2.2.3 Pre-Study Observations

Questions regarding oral health practices were asked of various parents and community workers, and this preliminary survey revealed that most children do not own toothbrushes unless provided to them. This community project did have toothbrushes provided to the parents, one year previously from CFCD workers, but were not instructed on how to use the brush, nor were they monitored or examined. Neem sticks, a paste consisting of ground up brick or charcoal, and fingers were the most common form of cleaning teeth before receiving a toothbrush. It was reported that 78% of children cleaned their teeth once a day, in the morning, with a duration of less than 20 seconds. Most parents did not see a need for the care of primary teeth, agreeing to the principle of 'they will fall out anyway', but were very curious and interested in learning, watching, and sometimes participating in the training sessions. White teeth are valued as important in the Indian culture, but appear lower in priority than performing well in school, getting a job, and getting married.

Statistics showed that 48.2% of all the children screened between ages of 5-13 had decayed lesions in the primary dentition; the rate for boys and girls being 49.5% and 47.1% respectively. Individual villages showed higher percentages of decay within the village groups, the highest observed value being 76.9%. Overall visible gingival inflammation was at a rate of 31.5%, and visible calculus was indicated at 21.0% (but varied amongst all age groups). All children showed signs of visible plaque.



Figure 2.7. Example of a local village shop with a big bag of hard sweets on display.

Villages with a local shop that supplied necessary items such as batteries, toothbrushes, toothpowder, wash powder, shampoo, soap, nuts, and snacks, also sell many varieties of sweets Figure 2.7.

As a special treat, parents often give children 2 Indian Rupees per day to visit the shop to purchase sweets Figure 2.8. Yet, the shops also provide toothbrushes and toothpowder but parents do not buy oral health products for their children and are not aware of the importance of oral health for children.

Those villages located closer to urban areas had higher rates of rampant decay and inflammation, when compared to those of the more distant villages. Local beliefs and customs discourage the pulling of teeth during the winter months for fear of mental illness. Therefore, many children revealed crowding, malocclusion and retained primary teeth, creating the image of two rows of teeth Figure 2.9. This occurs when there is no room for the permanent teeth to erupt as the primary teeth roots have not resorbed nor fallen out. The primary teeth block the pathway for normal tooth eruption, hence, the permanent teeth look for the next available position to erupt in.

This look often leads to embarrassment and social withdrawal, limited participation in school, and functional oral problems, such as difficulty with chewing and talking, hindering the normal development of the child and also increasing the incidence of oral disease and dental decay through the difficulty of cleaning Figure 2.10.



Figure 2.8. Example of available sweets inside local village shop.



Figure 2.9. Example of crowding & retained primary teeth (in front) creating two rows of teeth effect covered in plaque and food debris.



Figure 2.10. Examples of crowding & retained primary teeth in front, erupting permanent front incisors in the back, creating the two rows of teeth effect.

2.2.4 Requirement for Comprehensive Research

Needs assessment observation results demonstrated high levels of dental decay, developmental abnormalities and high levels of oral bacteria in children under the age of 12.

Dental awareness and knowledge was limited to visible appearance and absence of pain only. This observation therefore confirmed the need for increased awareness and the development and operation of promotional programmes within rural communities, including oral health education and activities for parents, children, and NGO community development teams. Hence, the requirement for the study described in the next section was indeed confirmed.

3.0 Materials and Methods

3.1 Study Experimental Design for Exploratory Purposes

The focus of this research was based on a longitudinal cohort experimental design for exploratory purposes conducted throughout a one year period, using a randomized cluster sampling of CFCD projects (parents, together with their children aged under 14 years), within the community developmental projects of HCDI, the partners of KNH organization in north India. The rural-tribal villages of Ambernath were located near Kalyan, within the State of Maharashtra, India (Figure 3.1). All villages had been actively partaking in the community developmental programmes for a time period of one year subsequent to a twelve-month probationary-trial period for acceptance into the NGO project programmes.

A mixed-methodology, using an exploratory participation evaluation approach, was designed to fit the needs of the study population, whilst taking into consideration access and availability of the NGO staff and sample participants, and also the appropriateness within cultural background, beliefs, and customs. The design was adapted to follow the local NGO developmental project style and concepts, and was simplified for ease of implementation. Moreover, major consideration was given to a financially- and logistically-attainable design, with the ability to apply it in only one visit, respecting the work and other developmental obligations of all participants, and anticipation of creating acceptance, sustainability, and behavioural changes.

Considerations for using existing participatory designs were explored and determined to be inappropriate for this research. The study of health communication and health behaviour change has been informed by a variety of models, which emphasise decision-making and attitudinal variables. For instance, the Trans-theoretical Model of Behaviour Change⁸⁶ is an example of this broader set of theories that rely on cognitive and attitudinal factors and suggest a staged decision making process that putatively underlies health behaviour, such as behavioural changes for smoking cessation and losing weight.⁸⁶ However, it proposes a somewhat linear process of change, which conceives of behavioural change as fitting Western cultures' thought processes and is arguably ethnocentric. The focus of developing communities is survival and finding the next meal for their children. These populations, once accepted into NGO training programmes, have already made the conscious decision to participate and make changes for a better life. They have also chosen to learn about cultural advancement, new sources of income and improved health, hence there are no contemplation phases, especially in this exploratory study. Once the relationship with the NGO and the sample groups had been created and accepted for involvement in a community developmental programme, the villagers can openly elect to participate or not. The new information for improvement of life tends to be embraced, especially if their children are involved. Furthermore, since the literacy rate is low, questionnaires aimed at complicated theories are too cumbersome and costly, and therefore clearly not an option for this type of study.

The Participatory Rural Appraisal (PRA)⁸⁷ was also reviewed as a potential theory. This method often is the most common used within community developmental projects, but was also not appropriate for this particular study. This method uses the feedback of already established leaders within the sample group, and has them identify and prioritize their needs, create self- empowerment and involvement within a process, and also provide feedback in the form of self-monitoring and reflection of the outcomes. This design is most appropriate for farming, livestock and agricultural developments⁸⁷⁻⁸⁹ Since this exploratory research and a subject matter would be new to community development programmes, which are initiated at the beginning of the NGO community developmental project, such groups had not been established when commencing this research programme. Moreover, the subject of oral health has never been included in such NGO activities, and therefore an awareness of the need was absent. The self-monitoring aspect would also be difficult, since these communities have other issues, which are more important at the beginning of the developmental project, such as clean water and access to food, overcoming malnutrition for their children, and sources of income.

This exploratory participation evaluation approach could serve to be a theory applied prior to using a modified version of PRA. It indeed brought not only awareness to the communities about oral health in children, and served to identify the strongest individuals within each test group. Additionally, it benefited the local NGO in identifying individuals who could serve as future leaders, teachers, and trainers for their future projects and programmes based around various issues.

The Theory of Planned Behaviour (TPB), (previously known as the Theory of Reasoned Action)⁹⁰ which looks into human behaviour through gathering data on attitudes and subjective norms to perceive a behavioural control before intervention was also considered. This theory was also not appropriate for this exploratory study, as the sample groups did not have any previous knowledge of the subject to be surveyed, therefore perceived beliefs and opinions were not available. However, an adapted version of this methodology might be a possibility for future research after an OHP course.

The research strategy was designed and sub-divided into four phases:

1. Phase 1: Questionnaire – completed to gain an improved understanding of local mind-sets about oral health in children, local customs and attitudes towards children's teeth, awareness of oral disease, and daily oral hygiene practices, and additionally to determine willingness to participate in such questionnaires.
2. Phase 2: Baseline Screenings – to determine the level of visible oral disease, decay and periodontal disease, in children under the age of 14, in four randomly selected villages of this NGO project.

3. Phase 3: Oral Hygiene Awareness Programme (OHAP) – to provide awareness and education of dental diseases, causes of oral disease, and how to prevent oral disease through effective toothbrushing techniques and oral hygiene habits. Additionally, the training of Experimental Test Groups (ETG) was completed during this phase.
4. Phase 4: One-year Follow-up – to gather completed questionnaires for mind-set comparisons, feedback about the OHAP, ease and sustainability of the programme, and dental screening data for comparative evaluations, study outcomes, suggestions and limitations.

3.2 Study Population

3.2.1 Questionnaires and Screening Participants

Thirty (n=30) KNH-HCDI Community-based projects, each having access of ten to fifteen villages, were considered for the study. Random sampling of the villages was performed after each fulfilled the filtering infrastructure criteria of availability or presence of:

- a. Water (boiled or treated).
- b. A village leader (formal or informal).
- d. A community centre, church, or building utilised as a school for the children.
- e. An animator or teacher for the village school.

- f. A population of approximately 50 children.
- g. No previous dental treatment or visits from local or volunteer dental professionals.
- h. An accessible location for the research team involved.
- i. Established women and children groups.
- j. A willingness to participate in the study for one year.

Four villages: Kuderan, Lavaliee, Kuradpada, and Chon within the Karunya Trust (Kalyan Diocesan Social Action Project), were chosen for participation in the OHAP. Each village fulfilled the participation requirements.

Figure 3.2 shows the clusters of villages and their corresponding project numbers within the local NGO, Karunya Trust, together with the partnerships of HCDI and KNH. The community development partnership programme had recently began in 2013 with a one year trial period before official acceptance into the developmental programmes of KNH. The villages of (Chon, Lavaliee, Kuradpada, and Kuderan), and their corresponding project numbers (1,9,10 and 13 respectively), were the randomly chosen villages for this study.



Figure 3.1. Google Maps (2017) Map of the Ambernath area of Karunya Trust Tribal Villages. Retrieved from <https://www.google.co.uk/maps/place/Ambernath,+Maharashtra,+India/@19.2173903,73.0940958,11.61z/data>

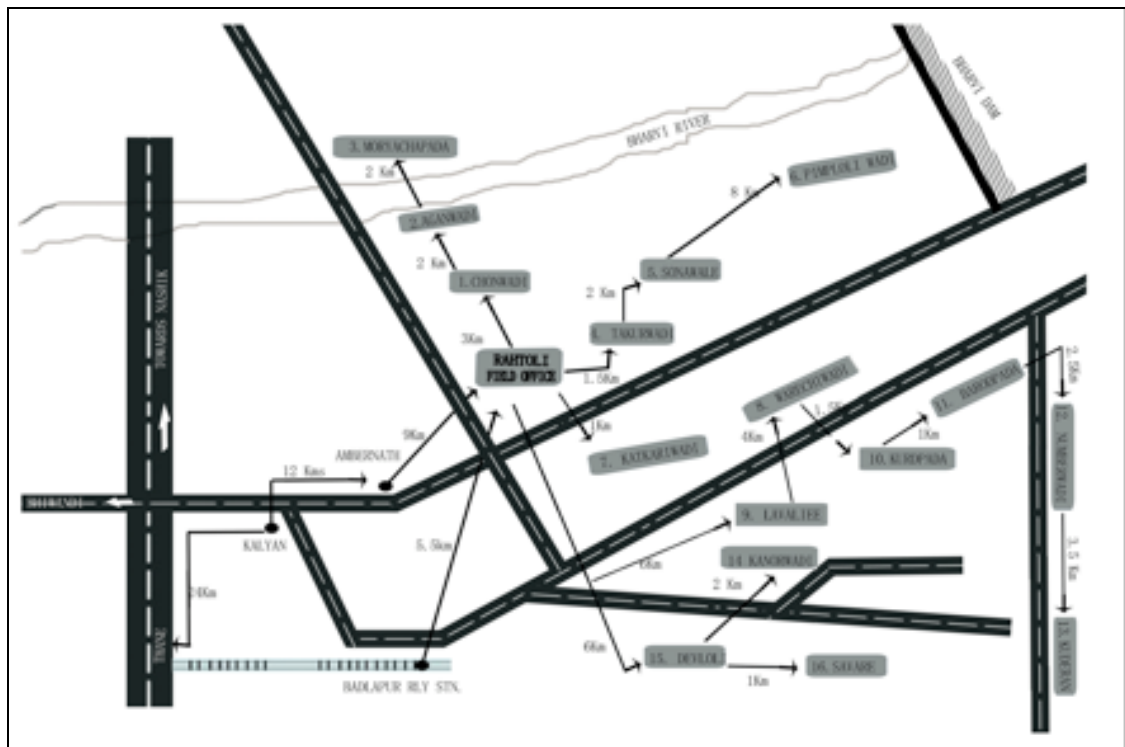


Figure 3.2. Karunya Trust Community Development Projects of Ambarnath tribal region and corresponding project numbers.

The final sample size used for the study for the Phase 1 questionnaire was $n = 202$ participating parents. The sample size grew during Phase 4, with the completed questionnaire size increasing to $n = 249$, since many parents, who were not able to participate the prior year with their child, in view of work and household priorities, could now partake. An additional collection of questionnaires $n = 130$, were also gathered from parents new to the OHAP in Phase 4, but were not included in the final analysis ascribable to the missing comparison data from Phase 1 Table 3.1.

Parents Participation in Questionnaires 2014-2015			
	Phase 1 Questionnaires	Phase 4 Questionnaires	New participants Questionnaires
Kuderan	50	44	33
Lavaliee	30	64	56
Kuradpada	79	80	22
Chon	43	61	19
n =	202	249	130

Table 3.1. Numbers of parents per village, participating in questionnaires during Phase 1 and Phase 4 of this study plus additional participants of questionnaire during Phase 4.

The total sample size for Phase 2, Dental Screenings was $n = 323$. This consisted of children between the ages of 1-14, with signed permission from their parents to be screened and then participate in the study. Non-compliant children $n = 7$, were omitted from the final analysis for a final sample size of $n = 316$. The Phase 4 Dental Screenings sample size decreased to $n = 237$ (Table 3.2), in view of various dropout issues which will be discussed in section 3.3.4.1.

Dental Screenings 2014- 2015				
	Phase 2-2014 Children screened	Phase 2-2014 Non- compliant	Phase 4-2015 Children screened	Phase 4-2015 Non- returning
Kuderan	63	0	45	18
Lavaliee	83	2	57	24
Kuradpada	89	1	76	12
Chon	88	4	59	25
n =	323	7	237	79

Table 3.2. Numbers of children per village screened during Phase 1 and Phase 4 of this study including non-compliant and non-returning

3.2.2 OHAP Test Groups

ETGs provided with the OHAP training programme consisted of:

1. WSHG (women's self help group)
2. CP Children's Parliament groups (adolescent ages 13-15)
3. CFCD team (local NGO community leaders, animators, local staff)

The randomization of various participants for the ETGs was not appropriate for this study considering the location and the peer-to-peer influence required for the trial.

WSHG and CP group participation was offered to all who met the requirements.

The NGO group comprised of all CFCD members and each participant was allocated according to the relationships established within the individual chosen village. Some of the NGO team lived in participating villages, whereas others supervised set NGO programmes in the chosen villages. A control group was not chosen for this study, since the study focus is observing the dissemination of information, peer-to-peer influence, cultural beliefs, customs, and NGO impacts on such communities.

Limiting the dissemination of information was not desirable, and nor was it practical to contain it.

3. 3 Contents of Study

3.3.1 Phase 1 (Questionnaire)

A specific questionnaire was designed for baseline and one-year follow up screenings in order to gather generalities of dental knowledge regarding village mind-sets, customs, practices, and beliefs. The questionnaire was translated into local language, Maharashtra, and filled out by 341 participants, specifically: Parents (202); Women Self Help Group (37); Children's Parliament Group (57); and local NGO staff members (45) in Phase 1. The questionnaire consisted of 14 questions pertaining to dental knowledge, dental hygiene awareness, local habits, and opinions Figure 3.3.

The questionnaire was given before the OHAP course, to all participants. Each participant answered the written questionnaire either on his or her own, or through the interpretation of a peer, who could read, write, and speak the local dialect. The final sample size analysed for the Phase 1 questionnaire was the group of parents, from each village, who completed the questionnaire at (n = 202). The parents of dental-screened children from Phase 1 answered the same questionnaire again during Phase 4. Both questionnaires were evaluated for comparative views and changes in opinions, after the one year OHAP, with a sample size of n = 249 Table 3.1.

Date of Survey
Village Name
Number

DMU

Oral Health Survey in Rural India

This questionnaire is designed to gather information as to your opinion about oral health. Please answer the questions truthfully. There are no right or wrong answers.

Please Fill in or Circle an answer

Age:	(1) Community Leader	(4) Childcare provider
(1) Male	(2) Grandparent	(5) Teacher
(2) Female	(3) Parent	(6) NGO team

1. How important is a healthy mouth?

(1) Very Important (2) Kind of important (3) Not Important

2. How important are Children's teeth?

(1) Very Important (2) Kind of important (3) Not Important

3. When should adults clean their teeth?

(1) Morning (2) Before Sleep (3) Both (4) Not at all

4. When should Children clean their teeth?

(1) Morning (2) Before Sleep (3) Both (4) Not at all

5. Is cleaning your tongue more important than cleaning your teeth?

(1) Yes (2) No

6. When a child has a loose baby tooth, what do you do?

(1) Wait till it falls out (2) Encourage wiggling to loosen (3) Pull it (4) Do nothing

7. When your child has dental pain, what do you do?

Write in answer:

(1) Visit Dr./Dentist (2) Do nothing (3) give Meds (4) take to hospital

January 2014

Date of Survey

Village Name

Number

8. Are you aware of how children's teeth affect permanent teeth?

Yes No

9. Do you know what dental disease is?

Yes No

10. Would you like to learn more about children teeth?

Yes No


11. Would you like to learn more about how to prevent toothaches & dental pain?

Yes No


12. Would you be willing to participate in a tooth-brushing program for your children?

Yes No


13. From the pictures below, which is most important?



Food




Shelter




Family

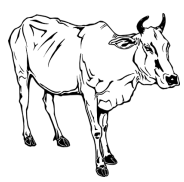
14. From the pictures below, which is last important?



Sweets



Childrens Teeth



Cow

Figure 3.3. (a) and (b), Oral Health Questionnaires pages 1 and 2 respectively.

3.3.2 Phase 2 (Baseline Data)

Two calibrated dental professionals acting as examiner and scribe took all baseline assessments using the WHO Oral Health Assessment 2012 for Children Guidelines at both the initial stage and the one-year follow-up episode.⁶¹ All children present were screened and involved in each phase of the study.

A sample of n = 316 children, between the ages of 1-14, were screened. Parents of participating children signed consent forms [Appendix 1(b)], and were given a participant information sheet [Appendix 1(c)]. All written information was verbally communicated and translated to all participants.

A single calibrated examiner and one scribe carried out the screenings using a sterilized mouth mirror, explorer, CPI ball-end probe, and mask and gloves. The children were checked for the visible presence of decay with DMFT (decay, missing, filled, and treated) scores. Only soft visible decay and extensive breakdown attributable to decay were recorded. Radiographs were not taken nor were the decay classifications recorded, since this was not a major objective of the study and dental facilities with necessary dental radiograph equipment were not available. The presence of gingival bleeding and the build-up of calculus (dental tarter) were recorded if observed, but were also not an objective of this study. Visible plaque scores were 100% in all children, and therefore this was also omitted from the screenings. The same method and materials were used during the one-year follow-up episodes and recorded.

3.3.3 Phase 3 (Oral Health Awareness Program (OHAP))

3.3.3.1 Training Team

The initial Oral Health Educational Team (OHET) comprised two dental professionals who were briefed, trained, and provided with teaching materials and products. The same team trained each ETG, and was present during every phase of this study.

3.3.3.2 Experimental Test Groups

Each non-dental Experimental Test Group (ETG) participated in an OHAP course which was completed in one half day. Each of the three ETGs attended the course within a group of their peers on different days. The first group was the WSHGs, who attended on day 1, the second the CP group, who attended on day 2, and the third, day 3 group consisted of a mixture of CDFC staff and other WSHGs and village health leaders who could not join the initial course within their peer group, in view of work or family responsibilities. All participants volunteered to come to the OHAP course and transportation to and from the training facilities were provided by the CFCD team.

3.3.3.3 Oral Health Awareness Course (OHAP)

The course was presented by the OHET team via an oral and visible presentation through the use of a local English-speaking NGO staff member who translated it into the local language Figure 3.6. The course was visually presented using a colour-printed A3 flip chart (Appendix 10.5), comprising 20 sides. The presentation gave an overview of dental disease (decay and periodontitis), how it occurs and how to prevent it. It also presented the stages of tooth development in children, according to age and what is

recognisable during each stage, and information regarding common conditions and which signs are normal to see at each stage of development

Figure 3.7. The causes and effects of each dental disease, their signs and symptoms, which systemic disease was linked to oral disease, photos of dental diseases in children, and how to recognize dental diseases, were also presented and taught.

The presentation concluded with oral hygiene instructions and practices Figure 3.8.

Toothbrushes and toothpaste were purchased in advance by the NGO, and then given to each participant of the OHAP, ETGs, children, and participating parents. All toothbrushing activities were practiced during the training sessions with the total sample size of participants in the OHAP being $n = 139$ Figure 3.9.



Figure 3.4. Photograph of the OHAP in progress for the WSHG group presented by OHET and the local NGO translator.



Figure 3.5. Photograph showing the OHET and local interpreter explaining the primary dentition and developing permanent dentition below bone and tissues.



Figure 3.6. Photograph showing OHET demonstrating effective toothbrushing techniques to WSHGs during OHAP training.



Figure 3.7. Photograph of interactive toothbrushing practice for all participants during OHAP.

3.3.3.4 Course Goals

The ETG objectives for the OHAP was to:

- a. Gain a simple understanding of dental diseases.
- b. Learn how to recognize dental problems in children: decay, crowding, inflammation, plaque, and tarter.
- c. Teach tooth-brushing techniques and how to implement an oral health programme at school, home, or during day care events.
- d. Educate the village regarding the development and recognition of dental diseases.
- e. Empower parents to take their children for dental treatment when required.

3.3.3.5 Course Implementation

Four days of training were carried out with each group receiving it on a distinctive day, organised according to local NGO recommendations in view of the relationship developed with each individual village, time schedules considerate of their work schedules, and distance of travel for ETG trainers. Each ETG chose two participants to initiate the OHAP on the next day after the initial OHAP, in one of the chosen four villages. WSHG delivered OHAP to Kuderan village on day 1 of OHAP implementation Figure 3.10. The CP group delivered OHAP to Lavaliee village on day 2, and NGO staff delivered OHAP on day 3 to Kuradpada village. On day 4, the village of Chon received OHAP from the CP group with assistance from the NGO group Figure 3.11.



Figure 3.8. Photograph of the WSHG group delivering OHAP to parents and children in Kuderan village on day 1.



Figure 3.9. CP group giving OHAP to Chon village parents under the guidance of the local NGO team on day 4.

The village programme began with the two trained test subjects presenting the OHAP to participating parents and children, followed by the distribution of toothbrushes with hands-on toothbrushing practice for all present parents and children Figure 3.12.

The same process was carried out in each of the four villages with two trained participants from each ETG Figure 3.13. Course presentations were monitored and observed by OHET and HCDI management team. Local NGO staff assisted with the appointment of each ETG team to a specific village in view of their having a better understanding of the local language, dialect, reading and writing skills, together with an in-depth knowledge of the area, local mind-sets, and locations.

The use of a control group was not considered since this study observes behaviours and the dissemination of information and motivational occurrences within the sample. All participants receive the same experimental protocol in their natural setting. It did not evaluate decay levels or extents of oral disease, only visible presences and changes in oral disease observations as one aspect of the study. The other aspects focused on the retention of information and changes in daily practices. Likewise, all ETGs are involved at every level of the NGO community development programme within the set area. Each ETG exerted a different influence on a village community, and will be addressed in the Discussion section.



Figure 3.10. Photograph of CP trainers giving toothbrushing instructions to Chon village children on day 4.



Figure 3.11. Photograph of Chon village children practicing toothbrushing with an ETG instructor.

3.3.3.6 Course Objectives

The objectives of this study were to observe which ETG group (n=139) may generate the most impact when introducing a new perspective to their peers. It was to observe if a mind-set, concerning dental disease prevention in children, can be changed, and if it can also motivate daily actions through education, guidance, and peer encouragement. It also aims to observe the utilisation of NGO staff and teams for dissemination of this information. Observational outcomes of the impact of teaching 'non-dental groups' oral health awareness information, and simple oral hygiene skills, were also witnessed. Hearsay of the study information would naturally occur in other villages involved within the same community development projects of the NGO, which could, in principle, 'sway' a control group. This is a desired effect of the OHAP, and therefore a control group was not appropriate for this study.

3.3.4 Phase 4: (One-year Baseline Data and Follow-up)

No interaction was undertaken with the test groups during the year following the initial OHAP and screenings. This was to monitor the success of the results acquired, i.e. if results showed that the OHAP education and training proved to be retained and sustainable.

The same questionnaire was provided again to participating parents of each of the four villages. Returning parents of the screened children from Phase 1 and 2, and who were present during Phase 4, follow-up (n = 249) took part in answering the questionnaire. An additional 130 new parents joined the OHAP group, i.e. those who were not

present during Phase 1, and they also completed a questionnaire Table 3.1, however these questionnaires were not entered into the analysis in view of compromising the comparison data answers of the original questionnaires between Phase 1 and Phase 4. Also, the children of the new parents were not included in the dental screening data sets during Phase 1, since this study focus was to observe decay changes, mind-sets variations and oral hygiene practices over a period of one year. This said, the new parent groups have already shown and expressed interest in the OHAP program, via 'word of mouth', by completing questionnaires and bringing their children in for a dental check ups and treatments if needed. Dental screenings were completed again on returning children from Phase 2, (n = 316). The Phase 4, Dental Screening final sample size was reduced to n = 249 in view of non-returning children n = 79 Table 3.2.

On conclusion of the screenings, dental cleanings in the form of ultrasonic and hand instrumentation, basic restorations, extractions, and pain relief procedures were carried out according to Atraumatic Restorative Treatment (ART) guidelines⁹¹ through a volunteer team from the Dental Hygienists and Therapists for India (DHFI) charity. All children present, either participating in the study or not, were screened and treated, if required.

3.3.4.1 Dropout

A dropout rate of 79 children did not return for the follow-up screenings Table 3.3. The attrition rate of 25% may be attributed to the timing of the research, since the initial phases were held during school holidays and most children were home during the

village OHAP training sessions. Also, visitors and relatives from other villages, were present during the initial phase of research, and were not excluded since it would be unethical not to allow all children to participate in the OHAP. The one-year follow-up was implemented during the school term, which witnessed a process that reduced the overall size of the baseline test group, as many children were away participating in school activities and sports. Also, some families had migrated to different regions and a few parents were not interested in the program nor having their children screened nor treated, if required Figure 3.14. Exact reasons for the non-interest could be in view of the children presenting disease free, so the parents did not see the need for more involvement, or for the opposite reason of high levels of decay and not wanting to be embarrassed or ashamed that there was no improvement. This however was not confirmed and could serve as a subject for further research.

Screening Drop-out Reasons 2015				
	Kuderan	Lavallee	Kuradpada	Chon
Hostel School	4	0	0	4
Day School	6	3	0	2
Visitor	6	0	0	1
Chores	2	3	0	0
Away at Relatives	0	5	5	4
Parents Not Interested	0	7	5	0
Sports Day	0	7	3	0
Migrated	0	0	0	12
n =	18	25	13	23

Table 3.3. Reasons for drop out of dental screenings for Phase 4 of the programme in 2015.

3.3.4.2 Statistical Analysis of Questionnaires and Dental Screenings

Data collection was compiled into Excel 14.0 data sheets and the statistical significance for questionnaire responses and calculus presence was determined using Fishers exact test. Screening data were normalized by dividing the cumulative frequencies for each age by the total number of decayed teeth, and a student's t-test was conducted to determine the statistical significance between the mean percentage change values for primary and permanent teeth decay levels.

An Analysis-of-Covariance (ANCOVA) model, which incorporated 5 factors and 6 primary sources of variation, specifically 'between-screening periods' (i.e. 2014 vs. 2015, qualitative) fixed effect, 'between-child participants' (qualitative) fixed effect, (3) 'between-participant genders' (qualitative) fixed effect, (4) 'between-villages sampled' (qualitative) fixed effect (V_i), and (5) 'between-ages of participants' (quantitative) fixed effect. This was performed in order to maximise precision in the testing of the 2015 vs. 2014 oral health screening index variables monitored, i.e. via the removal of potentially interfering or confounding effects arising from the 'between-child participants', 'between-participant genders', 'between-villages sampled', and 'between-participant ages' variables. A mathematical model for this experimental design is provided in Chapter 6.

3.3.4.3 Multivariate Principal Component Analysis (PCA) of Experimental Dataset

Principal component analysis of a 5 variable dataset (i.e. the primary teeth, permanent teeth, primary molar, permanent molar teeth, retained and decayed, and visible calculus variables) was conducted on raw (untransformed) data using the Pearson (n-1) model with a filter factor minimum of 80%. Varimax rotation was performed with a maximum of three factors, and application of the Kaiser normalisation process. Stop conditions involved a convergence value of 10^{-4} .

Factor loadings vector values of 0.40 were considered as the minimum required for a significant contribution towards each factor isolated.

4. Results Arising from Questionnaire Assessments

4.1. Questionnaire Participation

Amongst the 202 participants questioned in Phase 1, the majorities were female (n = 169) compared to male (n = 33). The respondents who completed the questionnaire were a varied mix of parents (n = 202), Women Self Help Groups (n = 37), village NGO health workers (n = 32), local NGO staff (n = 13), and the CP group (n = 57), for a total of 341 respondents.

However, the following were removed from the final analysis in view of replicating questionnaires: WSHG (n = 37), CP (n = 57), village health workers (n = 32), and CDFC staff (n = 13) for a total of 139 participants. Parents (n = 202) within the four villages have also been chosen for questionnaire analysis.

The Phase 4 results consist of those arising from n = 249 participants questioned, and again the majority are female (n = 230), with only a small number of males (n = 19). Only parents with children participating in dental screenings were accounted for in Phase 4 questionnaires. Additional questionnaire counts from 2015 may be ascribable to parents present during Phase 4 and not during Phase 1, or refusal to participate during baseline phase, and possible reasons for this was not determined at the time of the study.

4.2 Questionnaire analysis

4.2.1 Analysis of Question 2: How Important are Children's Teeth?

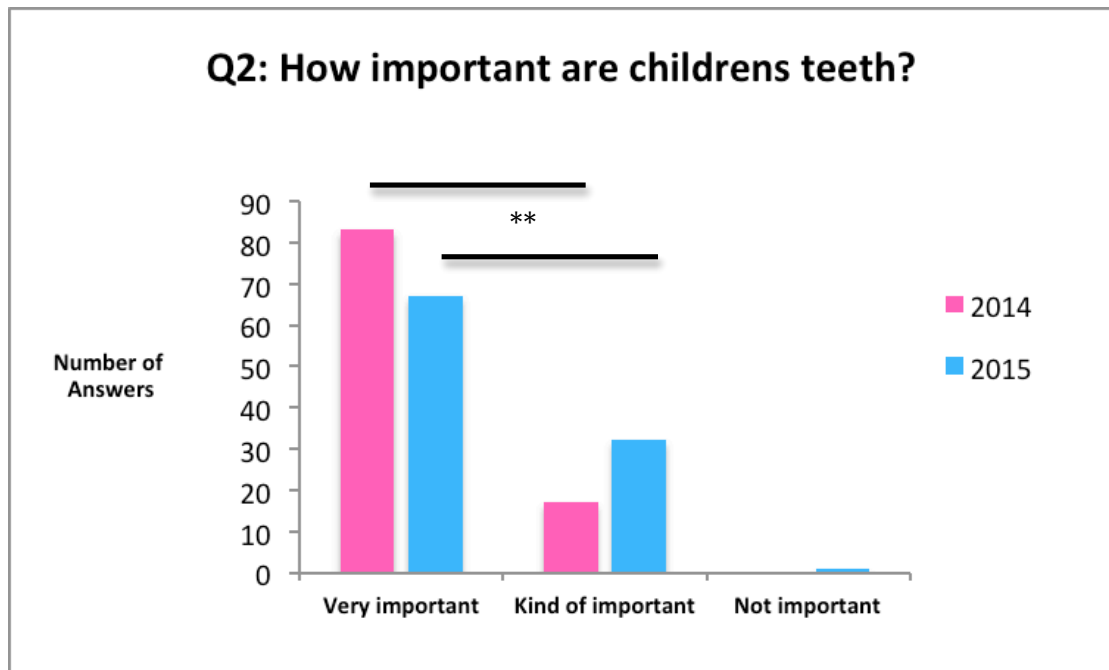


Figure 4.1. Bar diagram showing response (%) to question 2 in 2014 and 2015. ** indicates a significant difference with $p < 0.001$.

Analyses were focused on the perspective towards consideration of the importance of children's teeth between 2014 and 2015. These data (Appendix 2) show that the percentage of participants viewing the toothbrushing of children as very important was 83% in 2014 compared to only 67% in 2015. The percentage of participants viewing it as 'kind of important' increased from 17% in 2014 to 32% in 2015. There was a difference in percentage of responses, which was statistically significant ($p < 0.001$) between the "very important" to the "kind of important" responses. Statistical significance was calculated using Fisher's exact test; the number of participants answering this question was 200 in 2014, and 249 in 2015.

4.2.2 Analysis of Question 4: When Should Children Clean their Teeth?

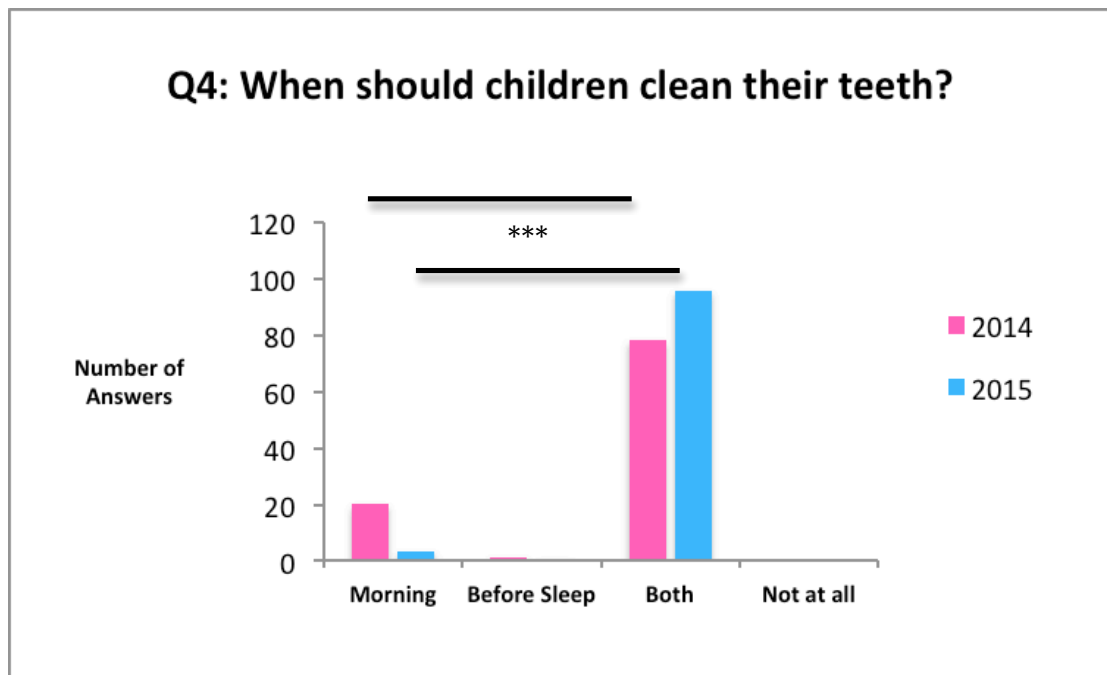


Figure 4.2. Bar diagram showing responses (%) to question 4 in 2014 and 2015
*** indicates statistical significance at the $p < 0.001$ level.

Analyses were conducted on the parent's perspective towards the frequencies of cleaning children's teeth between 2014 and 2015. These data (Appendix 2) show that the percentage of participants viewing the teeth brushing of children in the morning was 20% in 2014 compared to 3.6% in 2015. However, the percentage of participants viewing the cleaning of teeth both mornings and evenings increased from 78% in 2014 to 95% in 2015. There was a difference in percentage of responses which was highly significant in both years, ($p < 0.001$) between the "mornings" response to the "both" response. Statistical significance was calculated using Fisher's exact test, and the number of participants answering this question was 199 in 2014, and 249 in 2015.

4.2.3 Analysis of Question 5: Is Cleaning Your Tongue More Important Than Cleaning Your Teeth?

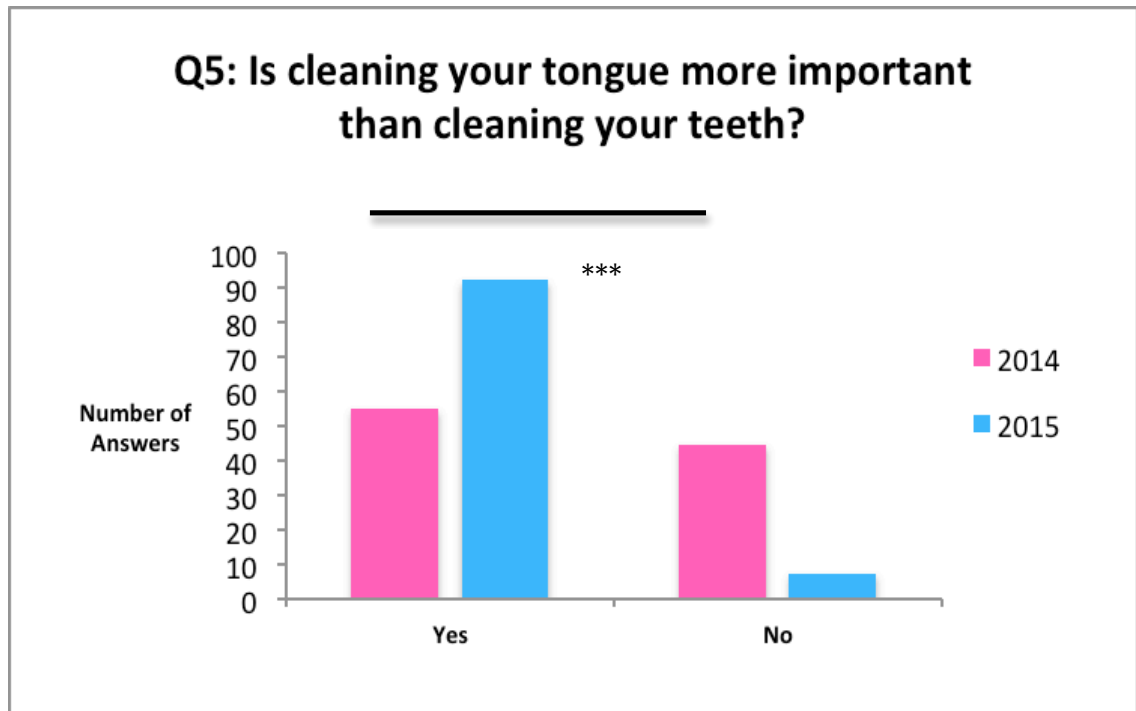


Figure 4.3. Bar diagram showing responses (%) to question 5 in 2014 and 2015
*** $p < 0.001$.

Analyses were focused on the perspective of cleaning the tongue as opposed to cleaning teeth between 2014 and 2015. These data (Appendix 2) show that the percentage of participants viewing the tongue as more important was 55% in 2014 compared to 92% in 2015. The percentage of 'no' answers from 44% in 2014 changed to 7.6% in 2015. The differences in percentage of responses were highly significant, ($p < 0.001$) between 2014 and 2015. Statistical significance was calculated using Fisher's exact test, and the number of participants answering this question was 201 in 2014 and 248 in 2015.

4.2.4 Analysis of Question 10: Would You Like to Learn More About Children's Teeth?

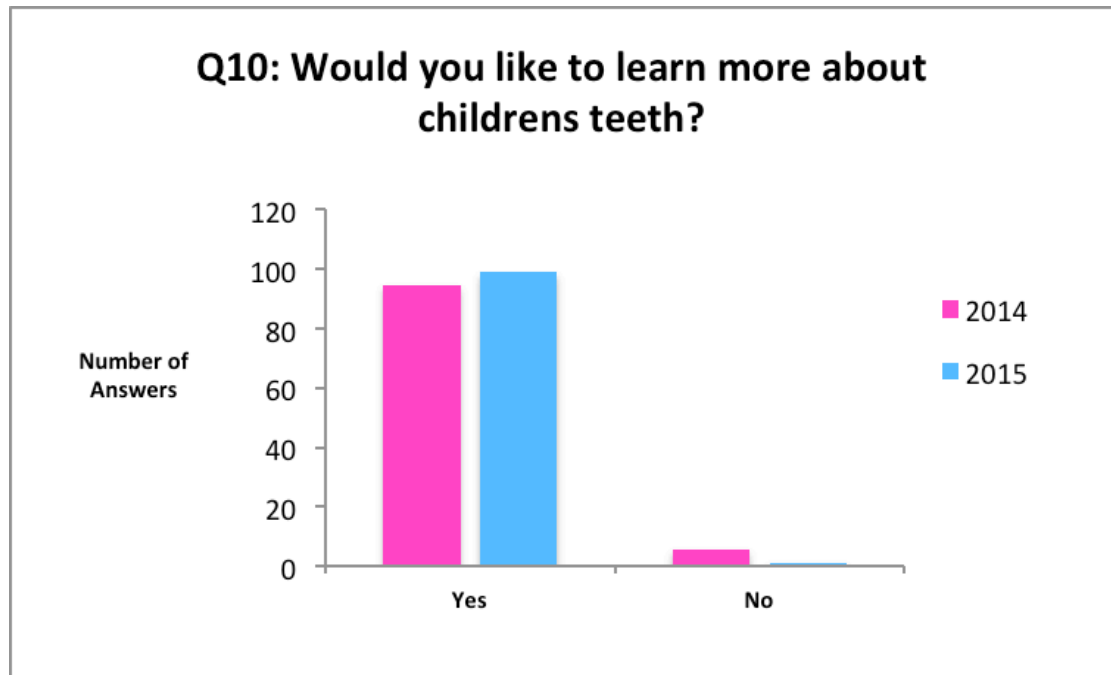


Figure 4.4. Bar diagram showing responses (%) to question 10 in 2014 and 2015.
* $p < 0.01$.

Analyses were focused on parents' interest in learning about children's teeth between 2014 and 2015. These data (Appendix 2) show that the percentage of participants interested in learning more was 94.4% in 2014 to 98.7% in 2015. The percentage of 'no' answers slightly decreased from 5.5% in 2014 to 1.2% in 2015. The differences in percentage of responses were statistically significant, ($p = 0.0118$) between 2014 and 2015. Statistical significance was calculated using Fisher's exact test, and the number of participants answering this question was 197 in 2014 and 249 in 2015.

4.2.5 Analysis of Question 13: Which is MORE Important Between Food, Shelter and Family?

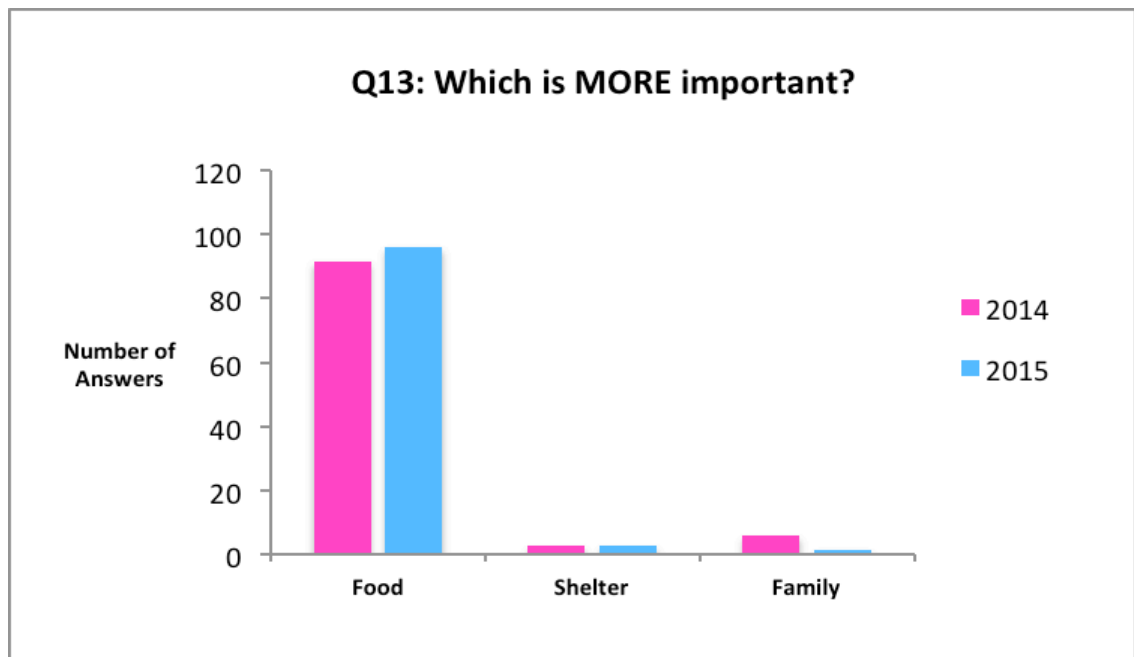


Figure 4.5. Bar diagram showing responses (%) to question 13 in 2014 and 2015.
* $p < 0.01$.

Analyses were focused on the views of what is 'most' important between food, shelter and family in 2014 and 2015. These data (Appendix 2) show that the percentage of participants chose food as most important at 91.6% in 2014 increasing to 96% in 2015. The percentage of the choice of shelter had no significant changes from 2.5% in 2014 to 2.6% in 2015. The differences in the percentage of responses to family as most important changed from 5.8% in 2014 to 1.3% in 2015. The p value for this difference was 0.0175, and the overall association between columns was statistically significant ($p < 0.001$) between 2014 and 2015. Statistical significance was calculated using Fisher's exact test, and the number of participants involved answering this question was 155 in 2014 and 226 in 2015.

4.2.6 Analysis of Question 14: Which is the LAST (Least) Important Between Sweets, Children's Teeth and a Cow?

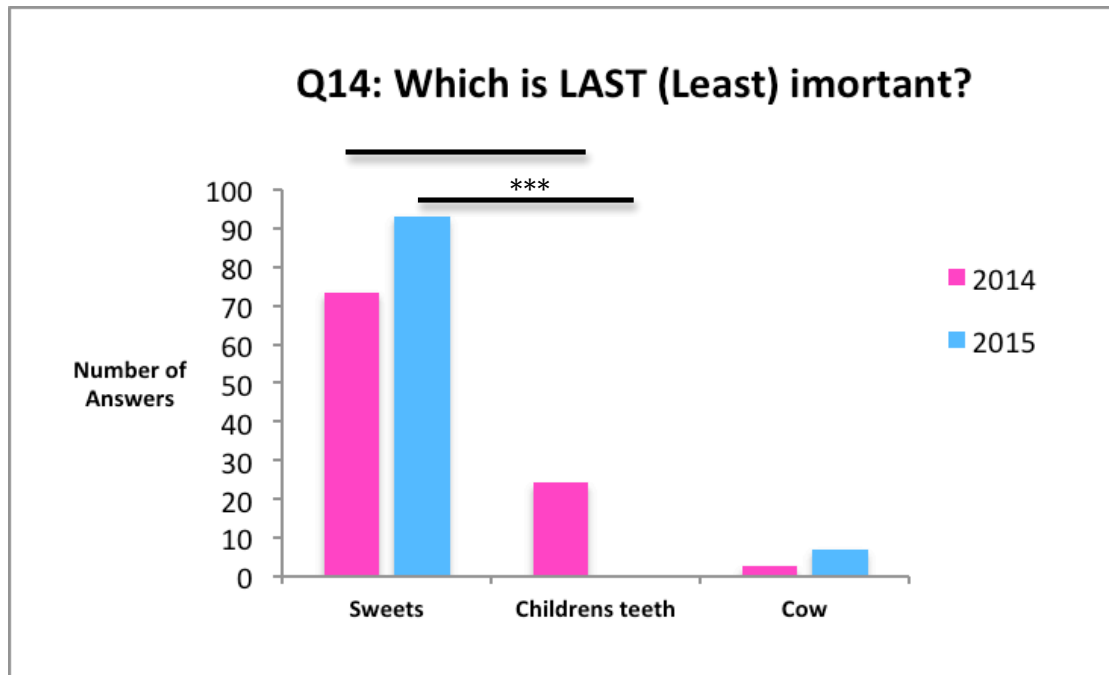


Figure 4.6. Bar diagram showing responses (%) to question 14 in 2014 and 2015. *** $p < 0.001$.

Analyses were conducted with a focus on the views of what is 'least (last)' important between sweets, children's teeth and a cow. These data (Appendix 2) show that the percentage of participants chose sweets as last important from 73.3% in 2014, a value increasing to 93% in 2015. The percentage of answers with children's teeth as the least important had a highly significant change from 24% in 2014 to 0% in 2015. The differences in percentage of responses to a cow as the least important marginally changed from 2.5% in 2014 to 6.9% in 2015. The difference in the association between columns is considered highly significant ($p < 0.001$) between 2014 and 2015. Statistical significance was calculated using Fisher's exact test, and the number of participants participating in this question was 199 in 2014, and 246 in 2015.

5. Results Arising from Dental Screening Evaluations

5.1 Baseline Screening Data 2014

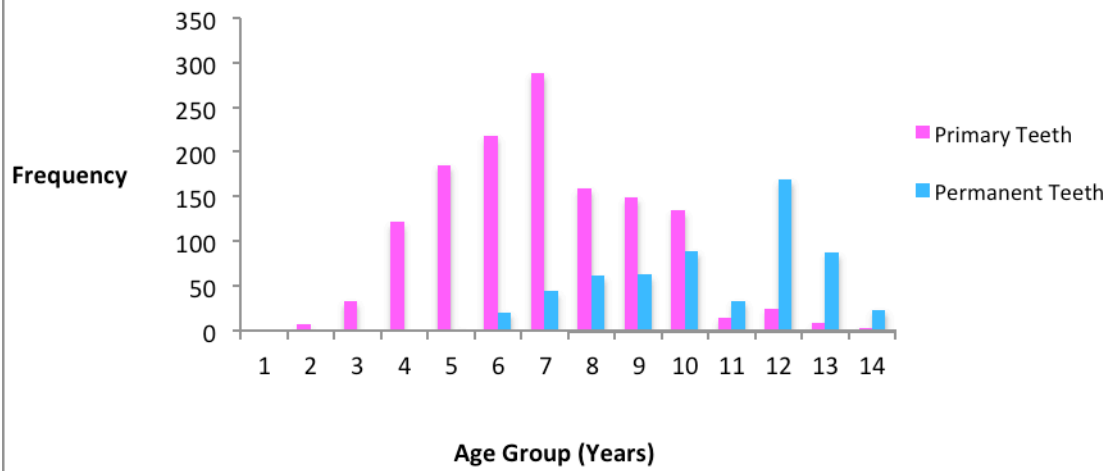
A sample of 316 children, i.e. 158 female and 158 male, between the ages of 1-14 with the mean age of 8 and a standard age deviation of 3, was screened in 2014. Findings demonstrated that 72.8% of children had a presence of dental decay, with the maximum mean average of 4.24 teeth per child. 69% of primary teeth and 55% of permanent teeth showed signs of visible decay. Visible calculus was observed in 23% of the sample population.

5.1.1 Analysis of Screening for Presence of Oral Disease in 2014

	Reported Age	Primary Teeth Decayed	Permanent Teeth Decayed	Primary Molar Decay (d,e's)	Permanent Molar Decay (6's)	Visible Calculus
Mean	8.1	4.2	1.8	3.1	1.3	0.2
SD	3.1	4.1	2.5	2.8	1.6	0.4
%	na	69.0	55.0	66.7	54.0	23.0
Totals	na	219	174	211	171	73

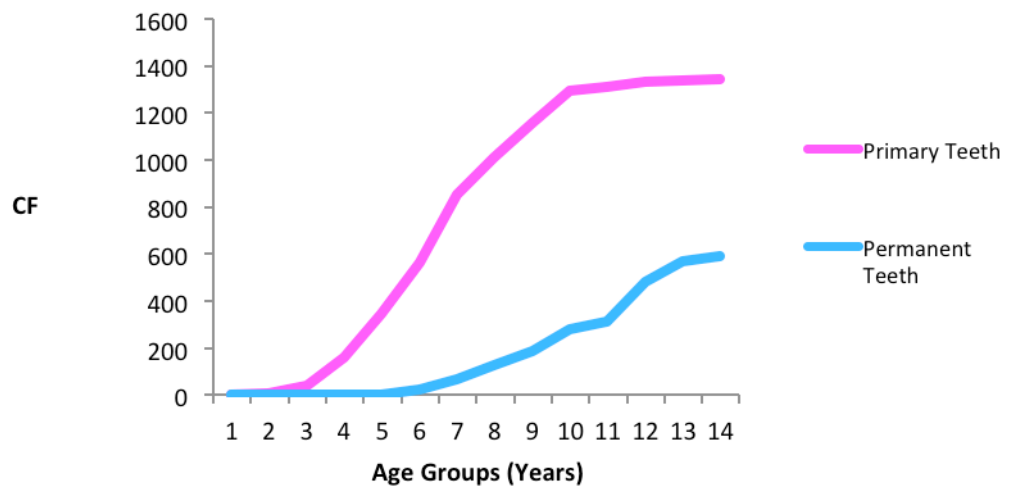
Table 5.1: Analysis of mean, standard deviation, percentages and totals of oral disease prevalence in 2014.

Frequency of Primary vs Permanent Decay 2014



(a)

Cumulative Frequency Graph 2014



(b)

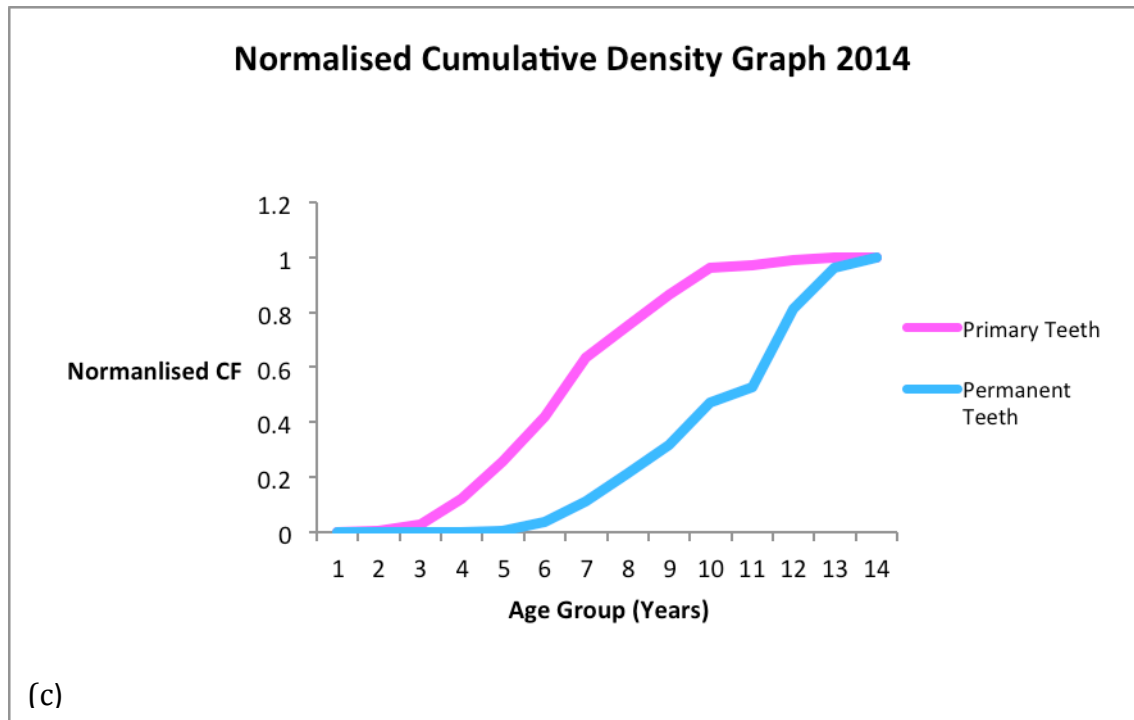


Figure 5.1. (a) Histogram showing the frequency of visible decay in primary and permanent teeth in 2014; (b) Cumulative frequency (CF) plot of visible decay in primary and permanent teeth in 2014; (c) Normalised cumulative density plot of visible decay in primary and permanent teeth in 2014.

The frequency histogram of primary and permanent decayed teeth counts shows a peak at age 7 for primary decay teeth, compared to a peak at age 12 for permanent teeth (288 and 169 teeth respectively). The histograms start to overlap within the age 6 to 14 range, as shown in Figure 5.1(a). Cumulative Frequency plots revealed that the number of decayed primary teeth was higher than the number of decayed permanent teeth, i.e. 1342 and 589 teeth respectively. This indicates a difference in decayed teeth as noted by the discrepancy in area of the cumulative frequency plots shown in Figure 5.1(b). Data were normalized to compare datasets in 2014 for primary and permanent teeth [Figure 5.1(c)]. Data were normalized by dividing cumulative frequency for each age by the total number of decayed teeth.

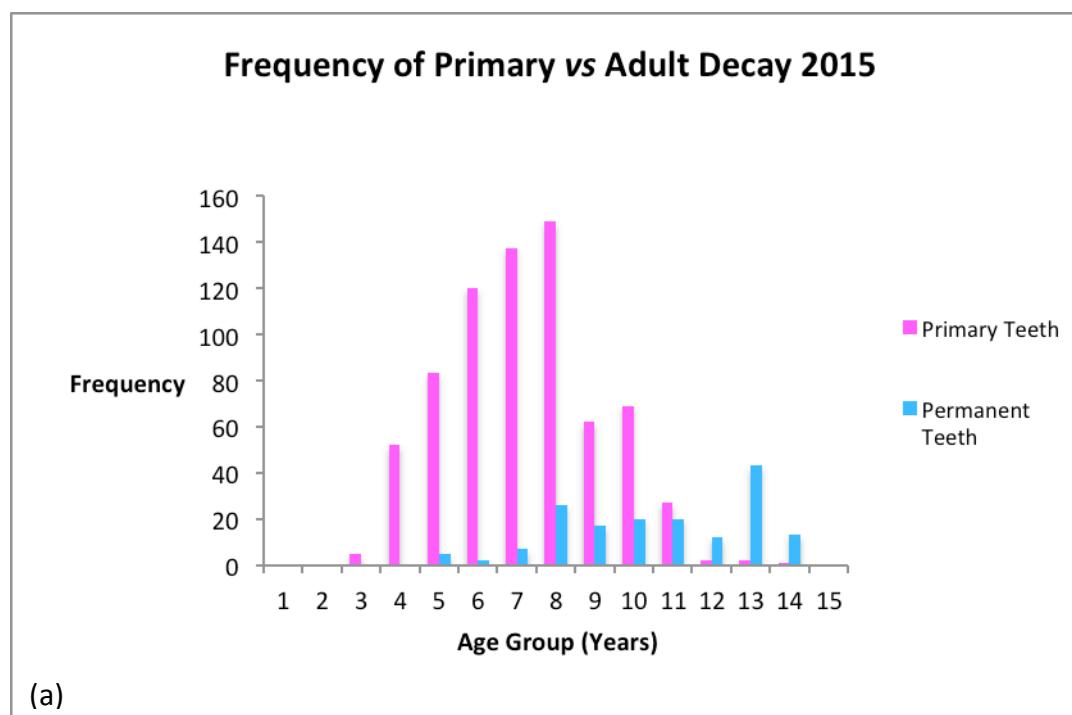
5.2 Baseline Screening Data 2015

A sample of 237 children, 127 female and 110 male, between the ages of 2-15 with a mean \pm SD age of 8.9 \pm 2.8 years, was screened in 2015. Findings revealed that 44% of children had a presence of dental decay with a mean average of 3 teeth per child. 66% of primary teeth and 29% of adult teeth showed signs of visible decay. Visible calculus was observed in 13% of the sample population.

5.2.1 Analysis of Screening for Visible Decay of Primary & Permanent Teeth in 2015

	Reported Age	Primary Teeth Decayed	Permanent Teeth Decayed	Primary Molar Decay (d,e's)	Permanent Molar Decay (6's)	Visible Calculus
Mean	9	0.6	0.3	0.6	0.3	0.1
SD	3	0.5	0.5	0.5	0.5	0.3
%	na	66.0	29.0	62.0	29.0	13.0
Totals	na	157	69	148	68	30

Table 5.2: Analysis of mean, standard deviation, percentage and totals of visible decay prevalence in 2015.



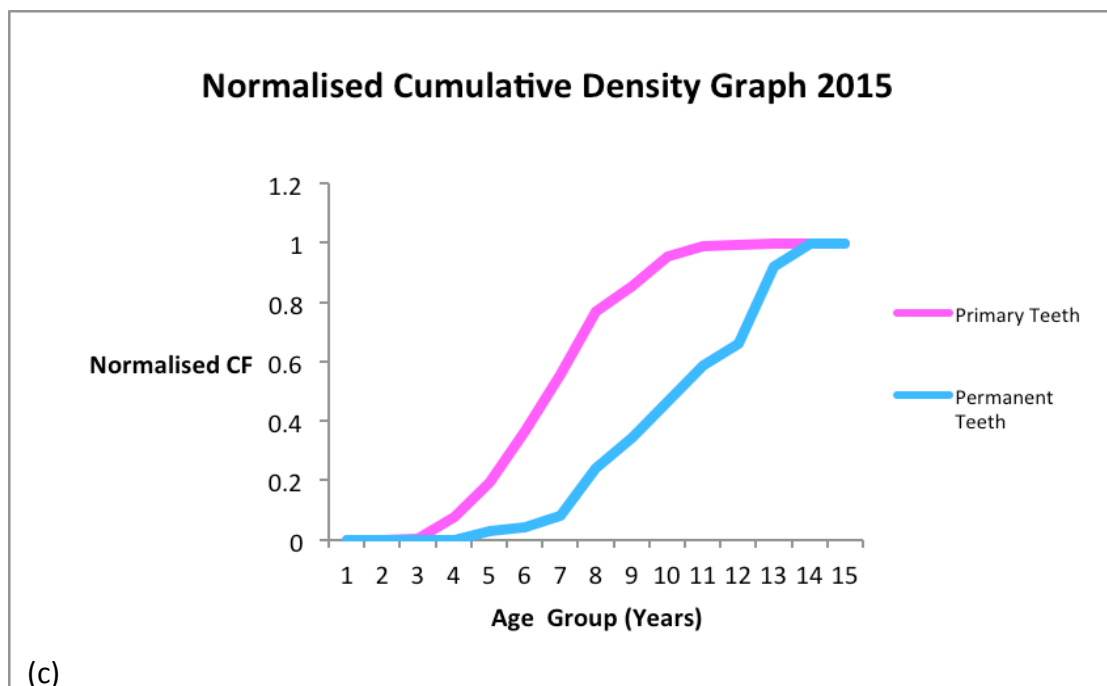
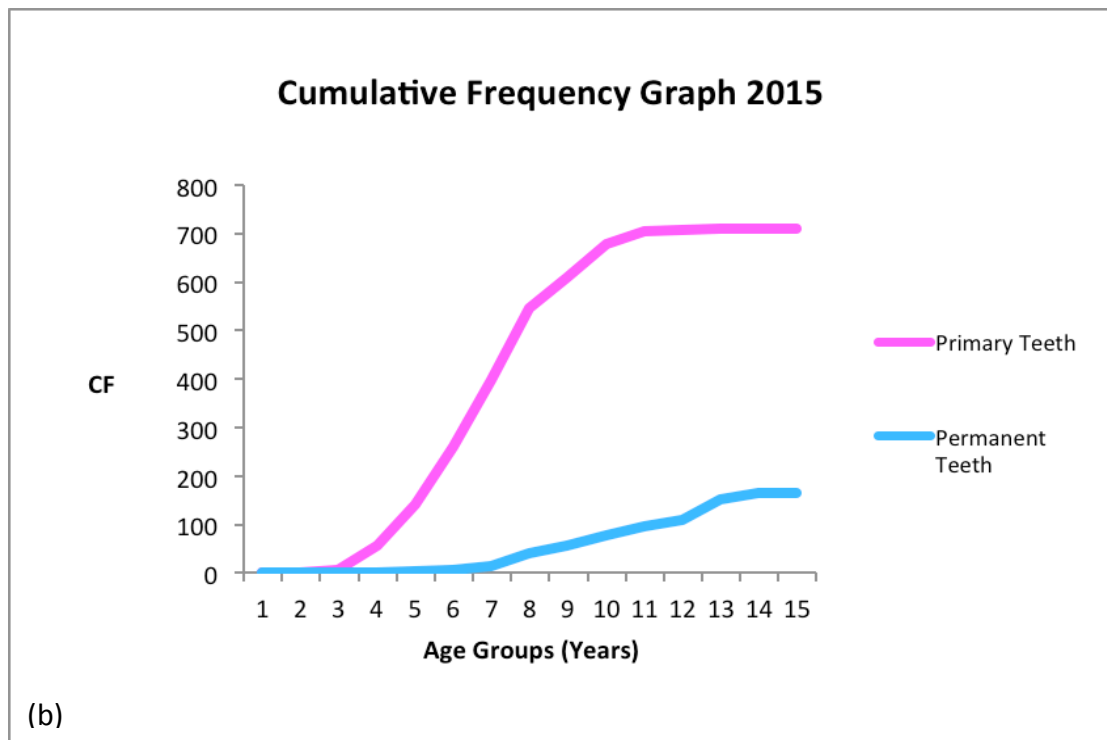
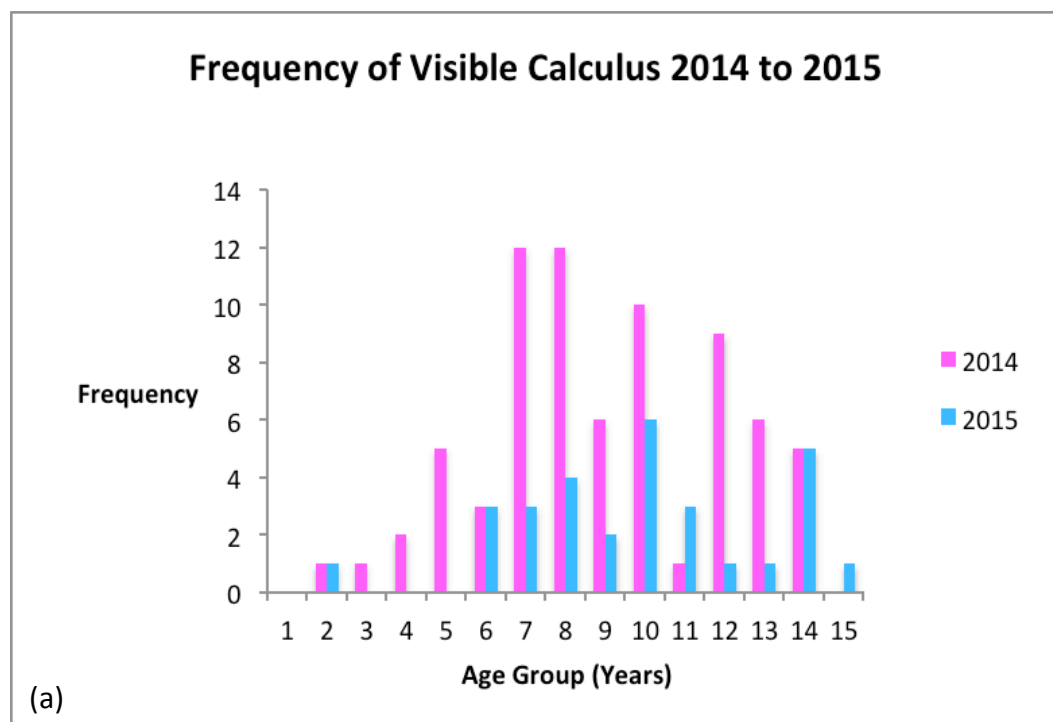


Figure 5.2. (a) Histogram showing the frequency of total teeth with visible decay in primary and permanent teeth in 2015; (b) Cumulative frequency (CF) plot of total teeth with visible decay in the primary and permanent categories in 2015; (c) Normalised cumulative density plot of total teeth with visible decay in both primary and permanent teeth in 2015.

The frequency histogram of primary and permanent decayed teeth counts shows a peak at age 8 for primary decay teeth compared to a peak at age 13 for permanent teeth. There were 149 teeth and 43 teeth featured respectively. The histograms commence overlap from age range 5 to 14, as shown in Figure 5.2(a).

A cumulative frequency was plotted and revealed that the number of decayed primary teeth was lower than that of decayed permanent teeth, i.e. 709 and 165 teeth respectively, indicating a large difference in decayed teeth as seen by the discrepancy in the area of cumulative frequency plots of Figure 5.2(b). Data were normalized to compare data sets in 2015 for primary and permanent teeth [Figure 5.2(c)]. Data were normalized by dividing the cumulative frequency for each age by the total number of decayed teeth.

5.3 Presence of Visible Calculus 2014 and 2015



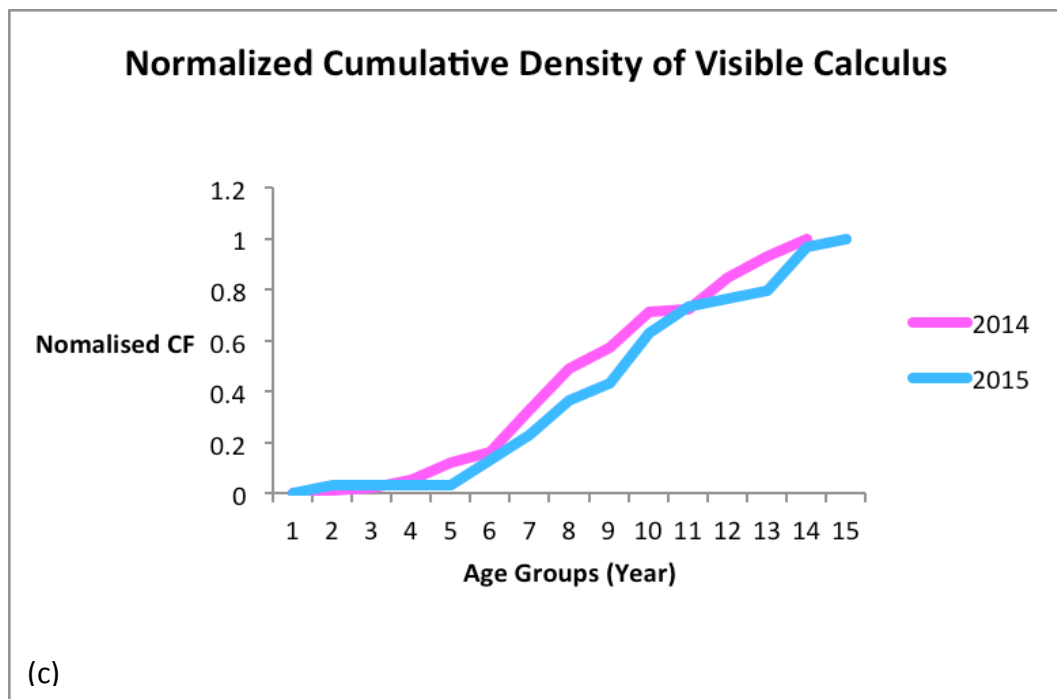
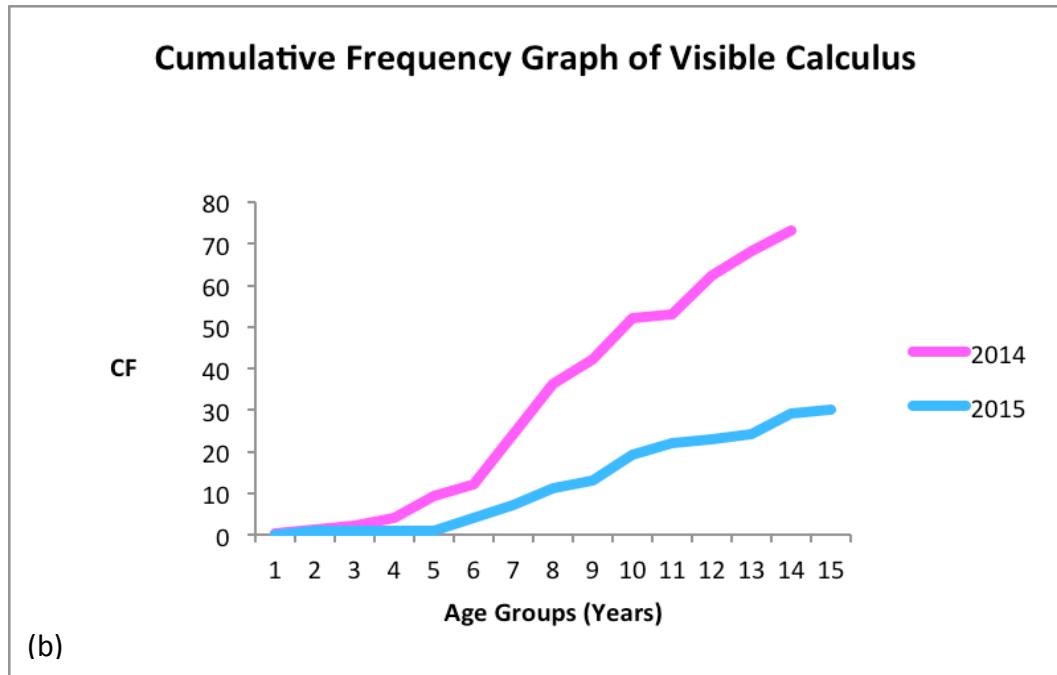


Figure 5.3. (a) Histogram showing the frequencies of the visible presence of calculus in 2014 and 2015; (b) Cumulative frequency plot of visible calculus in 2014 and 2015; (c) Normalized cumulative density plot of visible calculus in 2014 and 2015.

The frequency histogram displaying the presence of visible calculus in all ages revealed that higher counts peaked at ages of 7 and 8 in 2014. A change and reduction of visible calculus was observed at ages 10 and 14 in 2015 (this represents 12 and 6 children respectively). The histograms begin to overlap from age 6 onwards, although some calculus has been detected at age 2 as shown in Figure 5.3(a).

A cumulative frequency was plotted, and this revealed that visible calculus from 2014 was lower than that observed at the 2015 screening time-point, i.e. 73 and 30 teeth respectively. This indicates a difference in calculus seen by the discrepancy in area of the cumulative frequency plots displayed in Figure 5.3(b). Data were normalized to compare the datasets acquired in 2014 and 2015 for the presence of visible calculus as shown in Figure 5.3(c) and Table 5.2.

5.4 Comparison of Screening Data from 2014 and 2015

5.4.1 Percent Decay Variance between Primary & Permanent Molars 2014-2015

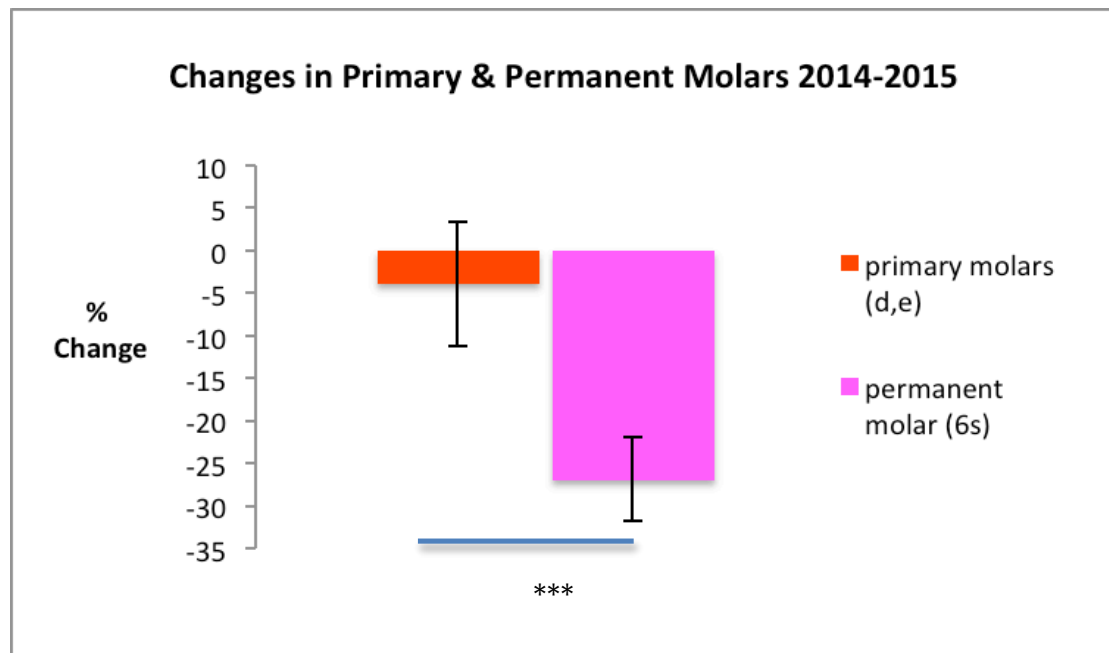


Figure 5.4. Bar diagram showing % change in the mean (\pm SEM) reduction in the incidence of decay in primary and permanent molars from 2014 – 2015.

*** $p < 0.001$ Error bars represent SEMS.

The results of the dental screenings were analysed with an overall focus of comparing the results acquired from screening episodes conducted in 2014 and 2015 [Appendix 3(a)], i.e. to determine if there was a difference in decay levels amongst the population following the OHAP programme. The mean percentage change of decay in primary and permanent molars was calculated from 2014 to 2015, and displayed in Figure 5.4. This showed that there was a small decrease in decay levels in primary molars from 69% in 2014 to 65% in 2015, i.e. an overall change of -3.6%. Permanent teeth showed a greater percent change from 55% in 2014 to 27% in 2015, i.e. a representative change of 28%. A student's t-test was conducted to determine the statistical significance between the mean percentage change values for primary and adult teeth decay levels. The computed p value was < 0.001 , indicating a highly significant statistical difference between mean percentage change values. Therefore, the year 2015 revealed a significant reduction of decay in both erupting and existing permanent teeth.

5.5 Mean Average of Decay per Child from 2014-2015

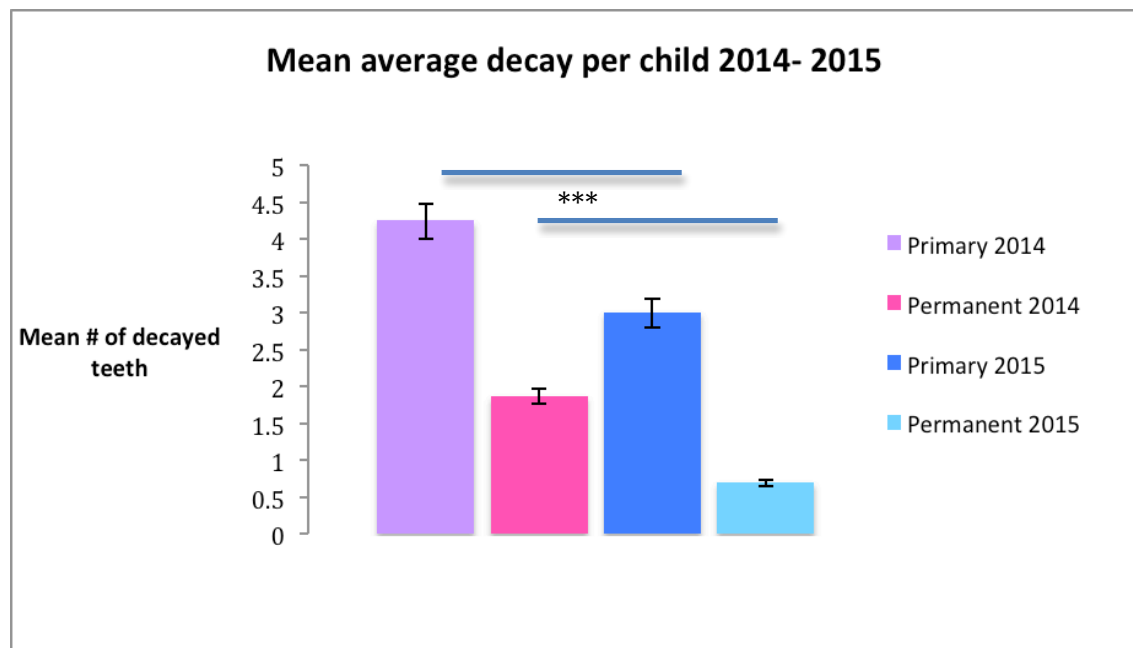


Figure 5.5. Bar diagram showing mean average per child of tooth decay in primary and permanent teeth from 2014 to 2015. *** $p < 0.001$ Error bars represent SEM values.

The results of the dental screenings were analysed with an overall comparison of the mean average per child of decayed primary and permanent teeth from 2014 to 2015 [Appendix 3(b)]. Figure 5.5 showed a mean \pm SD of 4.2 \pm 4.0 primary teeth, and 1.9 \pm 2.0 permanent teeth per child had decay. One-year later in 2015, the mean average has decreased to a mean average of (3.0 \pm 3.0) primary teeth and (0.7 \pm 1.0) permanent tooth per child has been observed (Table 5.4). A student's t-test was conducted to determine the statistical significance between the mean percentage change values between 2014 and 2015 in primary and permanent teeth. The computed p value was < 0.001 , indicating a highly significant statistical difference between mean percentage change values from 2014 to 2015.

5.6 Comparisons per Village

Individual Village % decrease in oral diseases					
	Kuderan	Lavallee	Kuradpada	Chon	Overall
Primary Teeth	4.8	-9.6	-5.4	-4.2	-3.6
Primary Molars (d,e)	4.8	-13.0	-2.2	-5.2	-3.9
Permanent Teeth	-32.0	-30.0	-23.0	-24.0	-27.5
Permanent Molars (6's)	-37.0	-17.3	-21.0	-19.0	-23.6
Calculus	-6.7	-8.9	-13.7	-12.6	-10.5

Table 5.5: Comparisons per village of the overall percentage of oral disease reductions.

The results of the dental screenings were analysed per village, with an overall focus of observing results acquired from screening episodes of dental disease from 2014 to 2015 (Table 5.5), i.e. to determine if there was a significant change per village.

Kuderan, the first village to receive the OHAP via the WSHG team, had the overall highest significant reduction of decay in permanent molars of 32%. However, it had a slight, non-significant increase in decay in primary molars of 4.8%. The village of Lavallee presented the greatest overall results of 9.6% decay reduction in primary teeth and 30% in permanent teeth. Kuradpada and Chon showed similar results in overall oral disease reduction from 5.4-4.2% in primary teeth and 23-24% in permanent teeth. Both Kuradpada and Chon villages showed the greatest overall reduction of visible calculus from 13.7 – 12.6%. A student's t-test was conducted to determine the statistical significance between the percentage change values for levels of disease. The computed *p* value was < 0.001, indicating a highly significant statistical difference between mean percentage change values. Therefore, the one-year difference revealed a significant reduction of decay in both erupting and existing permanent teeth.

5.6.1 Visible Decay Changes in Primary Teeth from 2014 to 2015

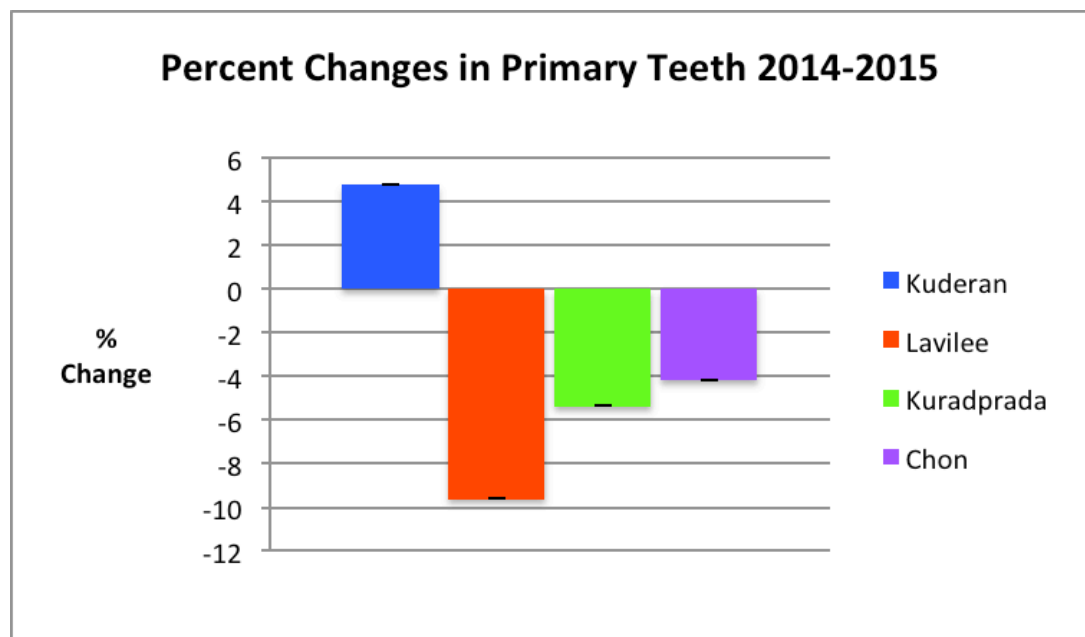


Figure 5.6. Individual village percentage changes of visible decay seen in primary teeth from 2014 to 2015. $p < 0.05$. Error bars represent SEM values of all villages.

A percentage change was calculated between populations for visible presence of decay in primary teeth studied between 2014 and 2015 [Appendix 4(a)]. The village of Kuderan showed a percentage of primary tooth decay increased by 4.7% from 62% in 2014 to 66.6% in 2015. Lavalee village had the greatest decrease in overall decay of 9.6% from 60.5% in 2014 to 50.8% in 2015. Kuradpada showed a smaller individual decrease of 71.6% in 2014 compared to 66.2% in 2015 with an overall decrease of 5.4% reduction in decay. Chon had a decrease with an overall results of 4.2% with 82.1% in 2014 to 77.8% in 2015. A change in the visible presence of decay seen in primary teeth was observed in the four villages between 2014 and 2015.

5.6.2 Visible Decay Changes in Permanent Teeth from 2014 to 2015

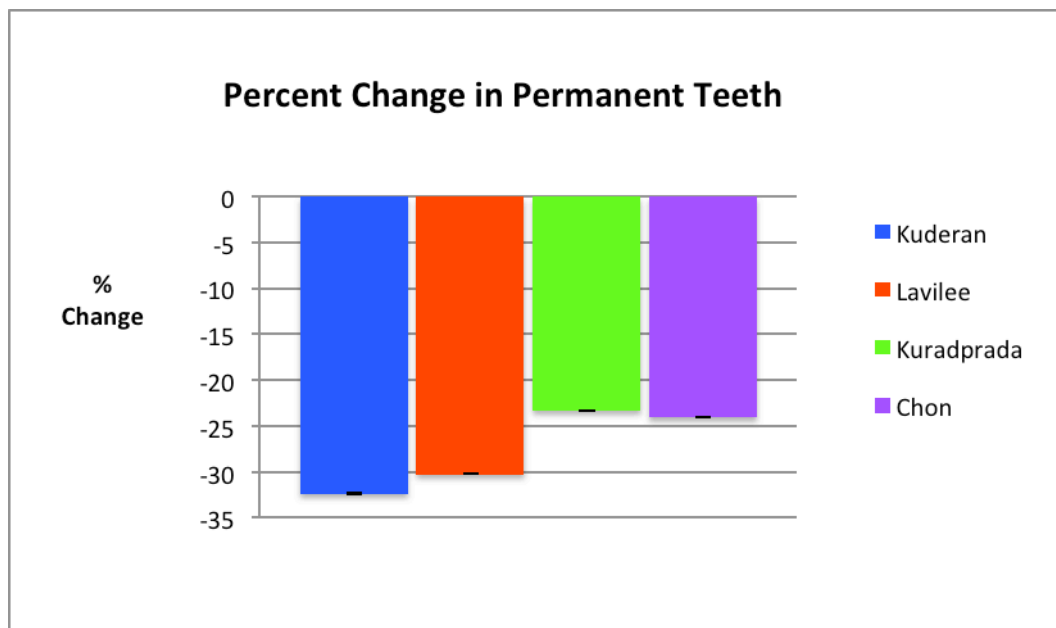


Figure 5.7. Individual Village percent changes of visible decay seen in permanent teeth from 2014 to 2015. $p < 0.05$. Error bars represent SEM values of all villages.

A percentage change was calculated between populations for visible permanent tooth decay in each village studied between 2014 and 2015 [Appendix 4(b)]. The village of Kuderan showed the greatest overall permanent tooth decay decrease of 32.4% being from 52.4% in 2014 to 20% in 2015. Lavalee village had a similar decrease of 30.3% from 53.1% in 2014 to 22.8% in 2015. Kuradprada showed 62.5% in 2014 compared to 39.2% in 2015 with an overall decrease of 23.3% reduction in visible decay. Chon had a smaller decrease with results of 24.1% with 51.2% in 2014 to 27.1% in 2015. A change in the visible presence of decay seen in permanent teeth was observed in the four villages between 2014 and 2015.

5.6.3 Visible Decay Changes in Primary (d,e) Molars from 2014 to 2015

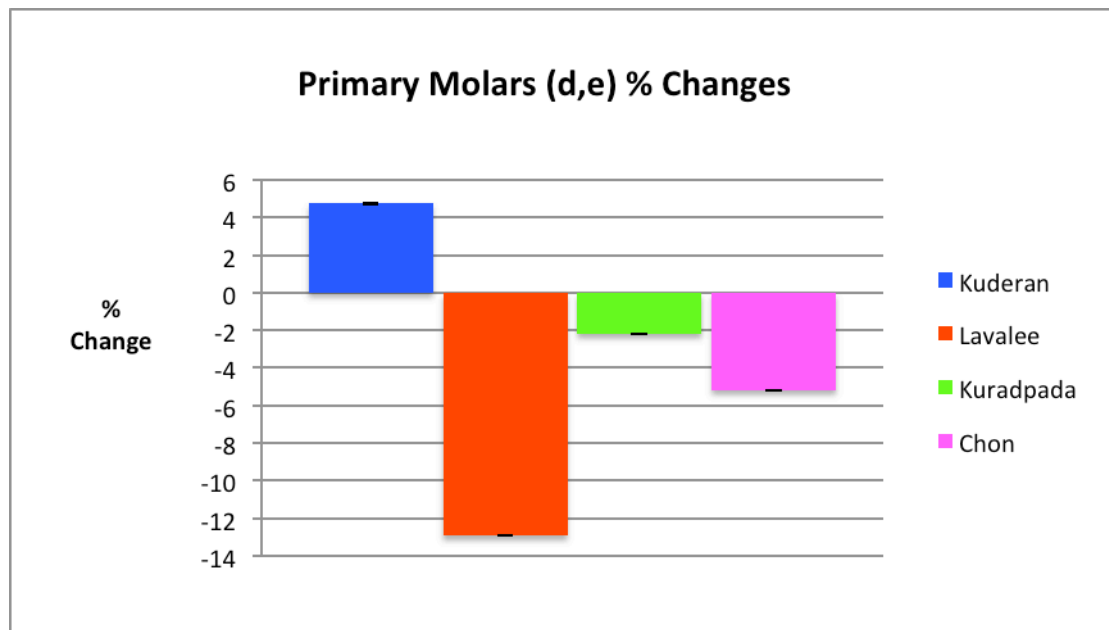


Figure 5.8. Percentage changes per village in the visible presence of decay changes in primary molars (d,e's) from 2014 to 2015 ($p < 0.05$). Error bars represent SEM values.

A percentage change was calculated between the populations for overall visible presence of primary tooth decay in each village studied between 2014 and 2015 [Appendix 4(c)]. The village of Kuderan showed primary tooth decay increased by 4.76% from 62% in 2014 to 66.7% in 2015. Lavalee village showed the greatest decrease in decay of 13% from 56.8% in 2014 to 43.8% in 2015. Kuradpada showed a smaller decrease of 67% in 2014 compared to 64.8% in 2015 with an overall decrease of 2.2% reduction in decay. Chon had a decrease with an overall results of 5.2% with 79.8% in 2014 to 74.6% in 2015. Visible presence of decay change in primary molars (d,e's) was observed in the four villages between 2014 and 2015.

5.6.4 Visible Decay Changes in Permanent (6's) Molars from 2014 to 2015

Visible presence of decay changes in permanent first molars was observed in the four villages between 2014 and 2015.

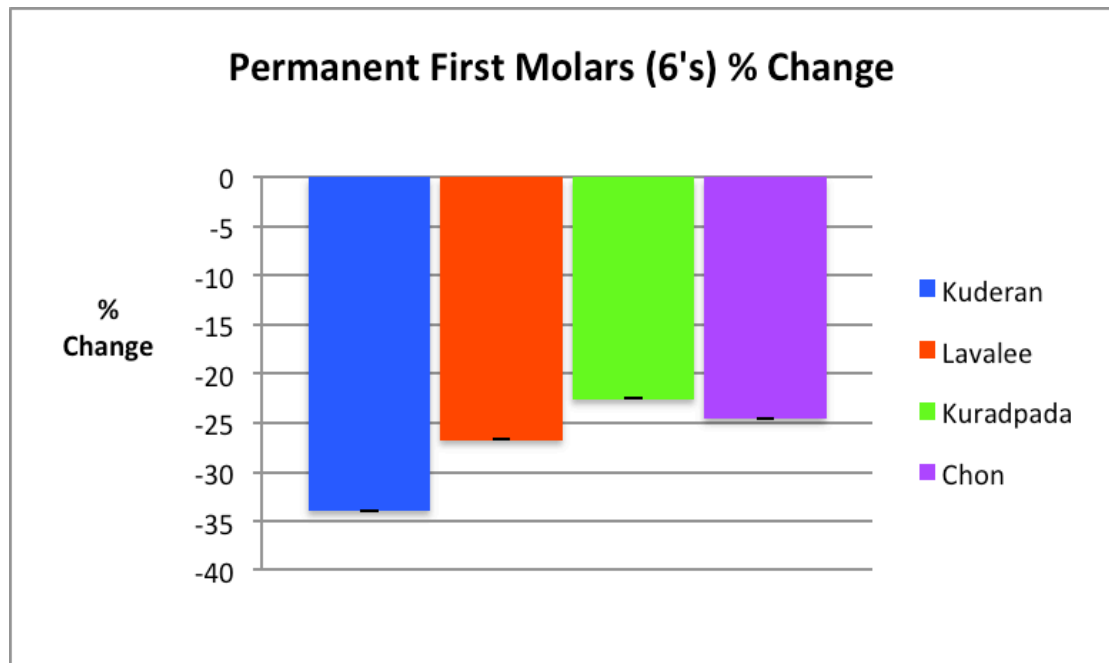


Figure 5.9. Percent change in permanent first molar (6's) per village from 2014 to 2015. ($p < 0.05$). Error bars represent SEM values.

A percentage change in visible presence of decay in permanent first molars (6's) was calculated between individual populations, studied between 2014 and 2015 [Appendix 4(d)]. The village of Kuderan had the most decrease of first permanent molar decay reduction of 34% followed by Lavalee village with 26.7%. Kuradpada showed a slight lower decrease of 22.6% compared to 24.6% in the village of Chon. All villages reported a decrease in permanent first molar visible decay presence reduction from 2014 to 2015 after participation in OHAP.

5.7 Visible Calculus Changes from 2014 and 2015

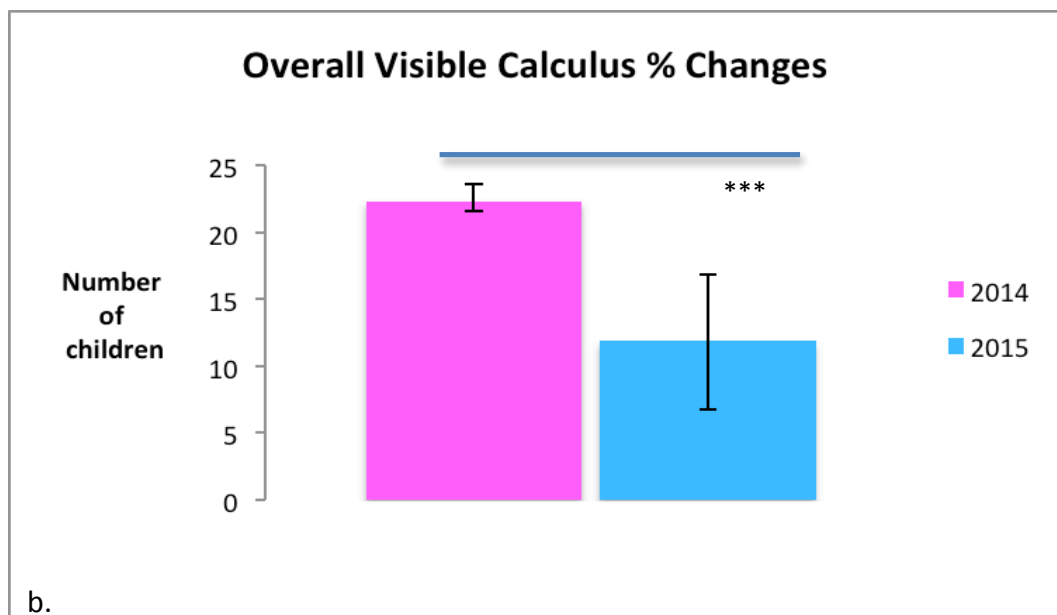
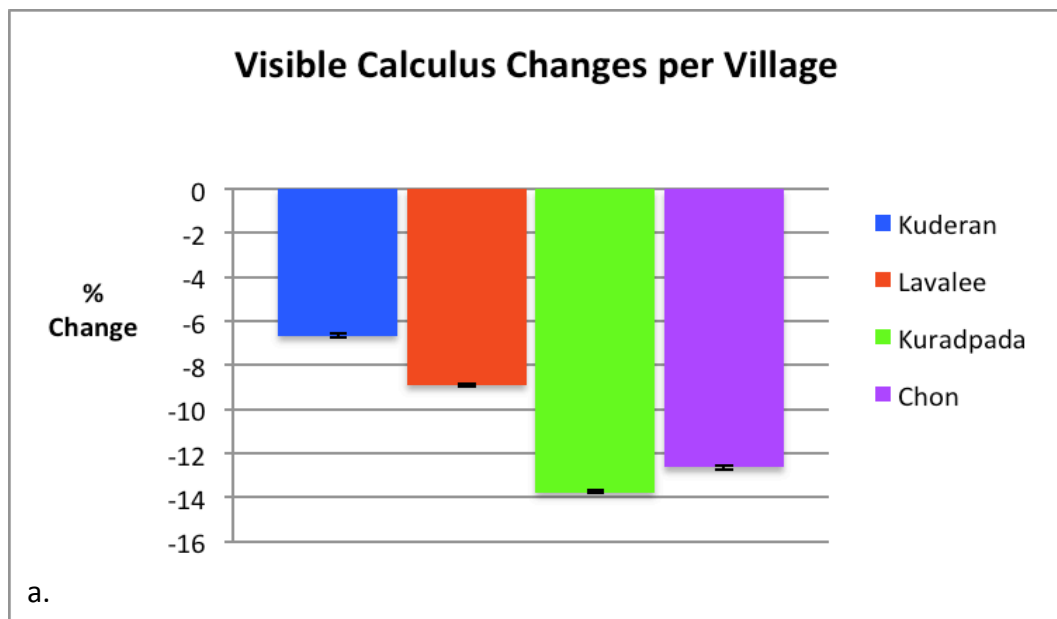


Figure 5.10. (a) Percent change in visible calculus per village from 2014 & 2015 (b) Overall mean percentage change in visible calculus per village from 2014 to 2015. *** $p < 0.001$ Error bars represents SEM values.

A percentage change was calculated between populations studied of visible calculus presence between 2014 and 2015 [Appendix 4(e)].

Figure 5.10(a) shows the village of Kuderan had a decrease in visible calculus of 6.6% and Lavalee with 8.9% decrease in presence of visible calculus. Kuradpada had the greatest decrease of 13.7% this being 27.2% in 2014 compared to 13.5% in 2015. Chon village closely followed with a decrease of 26.1% in 2014 to 13.5% in 2015 being an overall decrease of 12.6%.

Figure 5.10(b) shows all villages had an overall decrease in visible calculus from 22.3% in 2014 to 11.8% in 2015 after the OHAP. The differences in percentage were statistically significant, (***) $p < 0.1$) between 2014 and 2015. Statistical significance was calculated using Fisher's exact test.

6. Detailed Univariate and Multivariate Evaluations of the Oral Health Screening Datasets

6.1 Univariate Evaluations using an Analysis-of-Covariance (ANCOVA) Model

The experimental design for univariate analysis of the ^1H NMR ISB intensity datasets involved an Analysis-of-Covariance (ANCOVA) model, which incorporated 5 factors and 6 primary sources of variation: (1) 'between-screening periods' (i.e. 2014 vs. 2015, qualitative) fixed effect (S_i); (2) 'between-child participants' (qualitative) fixed effect (C_j); (3) 'between-participant genders' (qualitative) fixed effect (G_k); (4) 'between-villages sampled' (qualitative) fixed effect (V_l) ; and (5) 'between-ages of participants' (quantitative, A_m). This experimental design is represented by the mathematical model shown in equation 1, in which Y_{ijklmn} represents the (univariate) ISB predictor variable values observed, μ its overall population mean value in the absence of any significant, influential sources of variation, and e_{ijklmn} the unexplained error (residual) contribution.

$$Y_{ijklmn} = \mu + S_i + C_j + G_k + V_l + A_m + e_{ijklmn} \quad (1)$$

This experimental design permits an evaluation of the differences concerning the main variable of interest, i.e. oral screening score differences between the 2014 and 2015 evaluation sessions, after removal of all other potentially interfering and confounding sources of variation, specifically those ‘between-child participants’, ‘between-participant genders’, ‘between-villages sampled’ and ‘between-ages of participants’.

Such an approach maximises the precision of the experiment, i.e. it minimises the e_{ijklmn} term in equation 1.

Indeed, without using this strategy, all other components of variation will be included in and hence inflate this term, which is employed to test the significance of the major ‘between-screening period’ effect.

Type I Sum of Squares analysis (Variable: Primary Teeth):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	1	1678.0964	1678.0964	521.2336	$< 10^{-8}$
Child No.	237	4451.6067	18.7832	5.8342	$< 10^{-8}$
Treatment	1	40.8573	40.8573	12.6907	4×10^{-4}
Gender	0	0.0000			ns
Village	0	0.0000			ns

Table 6.1: ANCOVA Table: Variable of Primary Teeth Decayed. The 'Treatment' variable refers to clinical indices obtained prior and subsequent to the oral health promotion episode screenings conducted (i.e. 2015 vs. 2014). Abbreviations: DF, degrees of freedom; F, Fisher's F ratio statistic; Pr, probability.

For this dataset (Table 6.1), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was very highly significant ($p = 4.0 \times 10^{-4}$), specifically there was a major reduction in the primary teeth score when monitored in 2015 (Figure 6.1). Differences observed between the child participants and their ages/age groups were extremely significant ($p < 10^{-8}$). However, no significant 'between-gender' and 'between-village' effects were found.

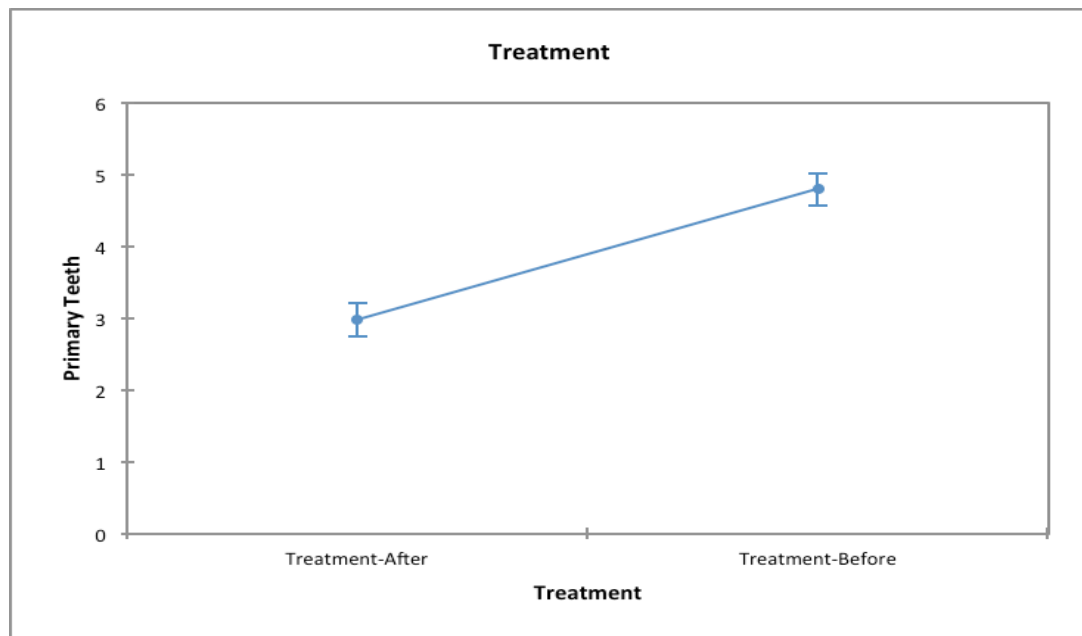


Figure 6.1. Plot of mean±95% confidence intervals (CIs) for the primary teeth scores found at the 2014 (before) and 2015 (after) oral health assessment screening periods.

Type I Sum of Squares analysis (Variable Retained & Decayed):					
Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	0	0.0000			
Child No.	237	271.6102	1.1460	1.9865	9.62 x 10 ⁻⁸
Treatment	0	0.0000			
Gender	0	0.0000			
Village	0	0.0000			

Table 6.2: ANCOVA Table: Variable of Retained & Decayed Primary Teeth.
Abbreviations: as Table 6.1.

For this retained and decayed dataset (Table 6.2), the only difference observed was that 'between-children' ($p = 9.62 \times 10^{-8}$). No significant explanatory effects were no between any of the other predominantly qualitative variables.

Type I Sum of Squares analysis (Variable Permanent Teeth):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	1	301.5036	301.5036	142.4919	$< 10^{-8}$
Child No.	237	1256.8010	5.3030	2.5062	$< 10^{-8}$
Treatment	1	14.2899	14.2899	6.7535	0.0100
Gender	0	0.0000			
Village	0	0.0000			

Table 6.3: ANCOVA Table: Variable of Permanent Teeth Decayed.

Abbreviations: as Table 6.1.

For this dataset (Table 6.3), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was significant ($p = 0.01$), specifically there was reduction in the permanent teeth score when monitored in 2015 (Figure 6.2). Differences observed between the child participants and their ages/age groups were extremely significant ($p < 10^{-8}$). However, no significant ‘between-gender’ and ‘between-village’ effects were found.

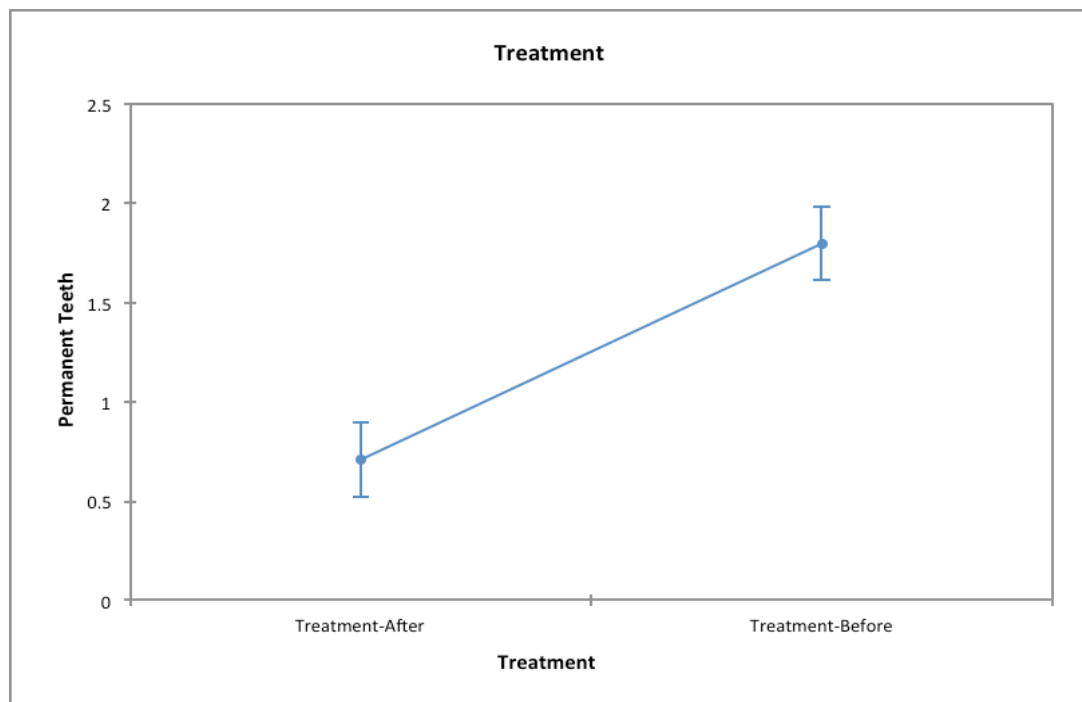


Figure 6.2. Plot of mean \pm 95% confidence intervals (CIs) for the permanent teeth scores found at the 2014 (before) and 2015 (after) oral health assessment screening periods.

Type I Sum of Squares analysis (Variable Primary Molars):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	1	663.0100	663.0100	484.5652	$< 10^{-8}$
Child No.	237	2401.4090	10.1325	7.4054	$< 10^{-8}$
Treatment	1	21.0860	21.0860	15.4108	0.0001
Gender	0	0.0000			
Village	0	0.0000			

Table 6.4: ANCOVA Table: Variable of Primary Molar Decayed.

Abbreviations: as Table 6.1.

For this dataset (Table 6.4), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was very highly significant ($p = 1.0 \times 10^{-4}$), specifically there was a major reduction in the primary molar teeth score when monitored in 2015 (Figure 6.3). Differences observed between the child participants and their ages/age groups were extremely significant ($p < 10^{-8}$). However, no significant 'between-gender' and 'between-village' effects were found.

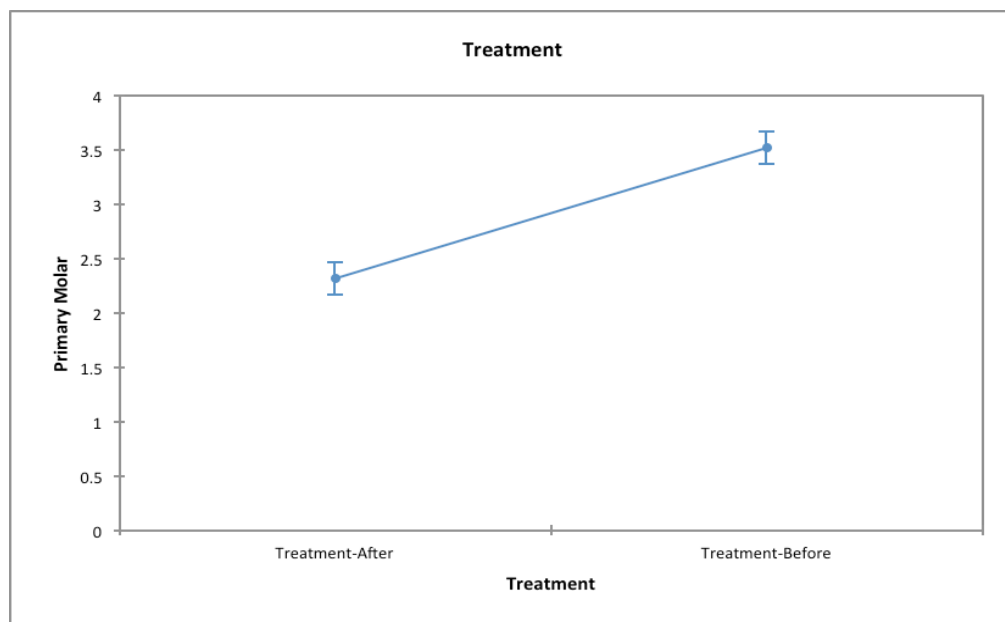


Figure 6.3. Plot of mean \pm 95% confidence intervals (CIs) for the primary molar scores found at the 2014 (before) and 2015 (after) oral health assessment screening periods.

Type I Sum of Squares Analysis (Variable Decayed Permanent Molar Teeth):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	0	0.0000			
Child No.	237	864.8644	3.6492	3.9547	$< 10^{-8}$
Treatment	1	52.0000	52.0000	56.3535	$< 10^{-8}$
Gender	0	0.0000			
Village	0	0.0000			

Table 6.5: ANCOVA Table: Variable of Permanent Molar Teeth Decayed.
Abbreviations: as Table 6.1.

For this dataset (Table 6.5), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was extremely significant ($p < 10^{-8}$), specifically there was a major reduction in the permanent molar teeth score when monitored in 2015 (Figure 6.4). Differences observed between the child participants were also found to be extremely significant ($p < 10^{-8}$). However, no significant 'between-age', 'between-gender' and 'between-village' effects were found.

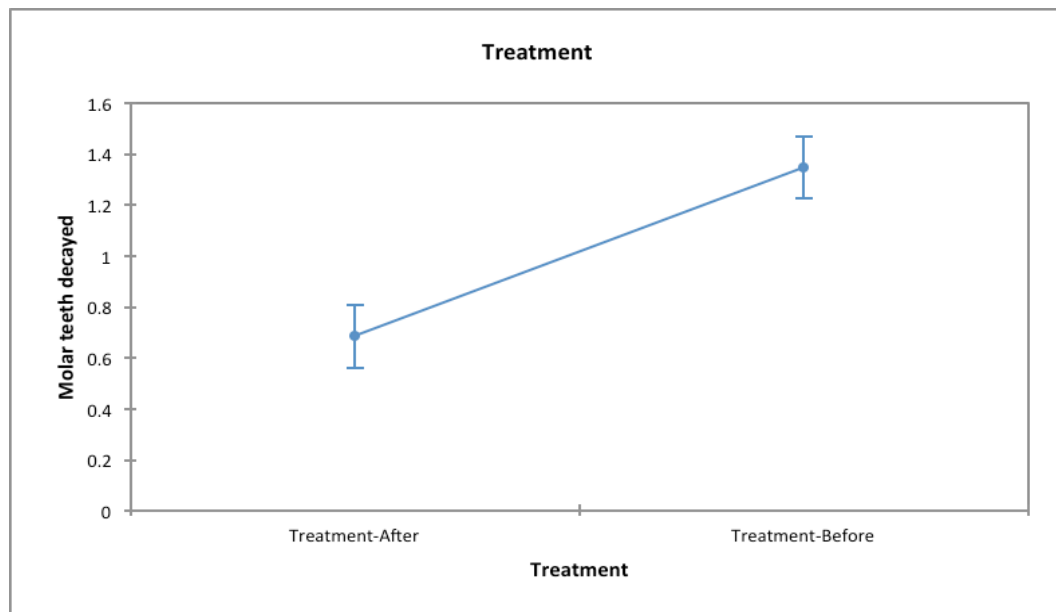


Figure 6.4. Plot of mean \pm 95% confidence intervals (CIs) for the permanent molar teeth decayed scores found at the 2014 (before) and 2015 (after) oral health assessment screening periods.

Type I Sum of Squares Analysis (Variable Mixed Dentition):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	1	0.3478	0.3478	3.3434	0.0688
Child No.	237	89.0339	0.3757	3.6115	$< 10^{-8}$
Treatment	0	0.0000			
Gender	0	0.0000			
Village	0	0.0000			

Table 6.6: ANCOVA Table: Variable of Mixed Dentition.
as Table 6.1.

Abbreviations:

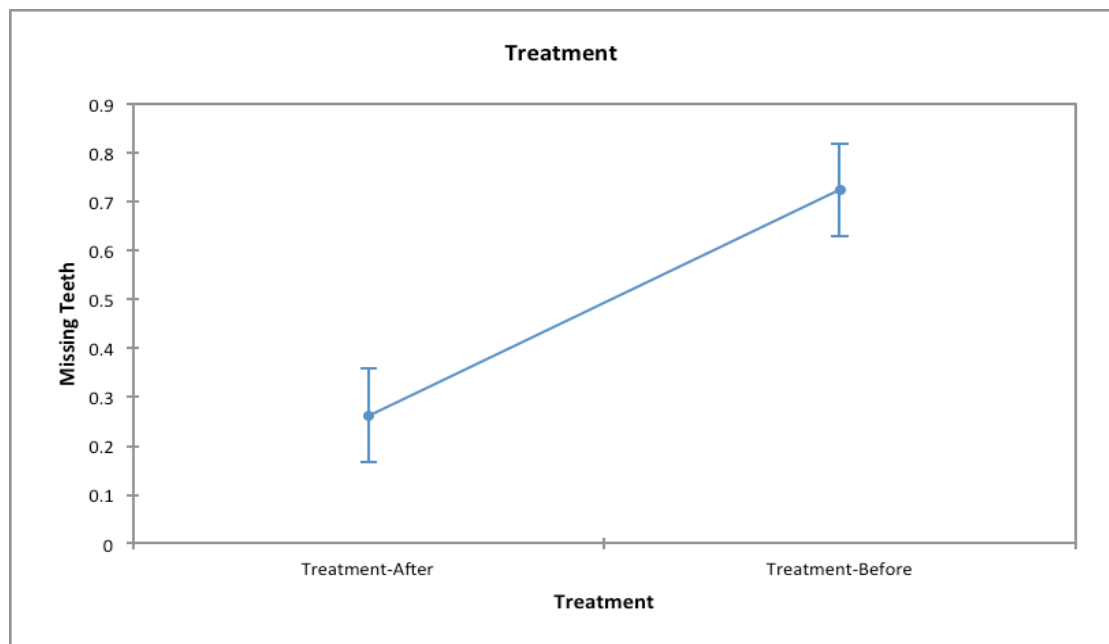
For this dataset, the only significant difference observed was that ‘between-children’ ($p < 10^{-8}$). Although that ‘between-ages’ was close to statistical significance ($p = 0.0688$), none of the other potential explanatory variables tested were as all of the test groups were of mixed dentition.

Type I Sum of Squares analysis (Variable Missing Teeth):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	0	0.0000			
Child No.	237	341.9809	1.4430	2.6085	$< 10^{-8}$
Treatment	1	23.1111	23.1111	41.7793	$< 10^{-8}$
Gender	0	0.0000			
Village	0	0.0000			

Table 6.7: ANCOVA Table: Variable of Missing Teeth. Abbreviations: as Table 6.1.

For this dataset (Table 6.7), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was extremely significant ($p < 10^{-8}$), specifically there was a major reduction in the missing teeth score when monitored in 2015 (Figure 6.5). Differences observed between the child participants were also extremely significant ($p < 10^{-8}$). However, no significant ‘between-age’, ‘between-gender’ and ‘between-village’ effects were found.

**Figure 6.5.** Plot of mean \pm 95% confidence intervals (CIs) for the missing teeth scores found at the 2014 (before) and 2015 (after) oral health assessment screening periods.

Type I Sum of Squares analysis (Variable Visible Calculus):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Age	1	5.8391	5.8391	75.8033	$< 10^{-8}$
Child No.	237	43.9673	0.1855	2.4084	$< 10^{-8}$
Treatment	0	0.0000			
Gender	0	0.0000			
Village	0	0.0000			

Table 6.8: ANCOVA Table: Variable of Visible Calculus. Abbreviations: as Table 6.1.

For this dataset (Table 6.8), the difference observed between the mean values noted at the two screening periods (2015 vs. 2014) was not significant ($p < 0.05$), specifically there was no difference in the visible calculus score variable between the two screening years.

Differences observed between the child participants and their ages/age groups were, however, extremely significant ($p < 10^{-8}$). No significant 'between-gender' and 'between-village' effects were found.

6.2 Permutation Analysis

6.2.1 Permutation Analysis performed via Partial Redundance Analysis (P-RDA)

Further validation was performed with *XLSTAT2016*, which employed permutation testing via partial redundancy analysis (P-RDA) with all variables but the evaluation one serving as 'conditioning' variables, and 2×10^3 permutations.

P-RDA Permutation Analysis

Further validation was also performed with *XLSTAT2016*, which employed permutation testing via partial redundancy analysis (P-RDA) with all variables but the evaluation (targeted) one serving as 'conditioning' variables, and 2×10^3 permutations.

Results of the permutation test:

Permutations	2000
Pseudo F	0.11668566
p-value	$< 10^{-8}$
alpha	0.05000000

Table 6.9: Permutation Test of Screenings (2015 vs 2014).

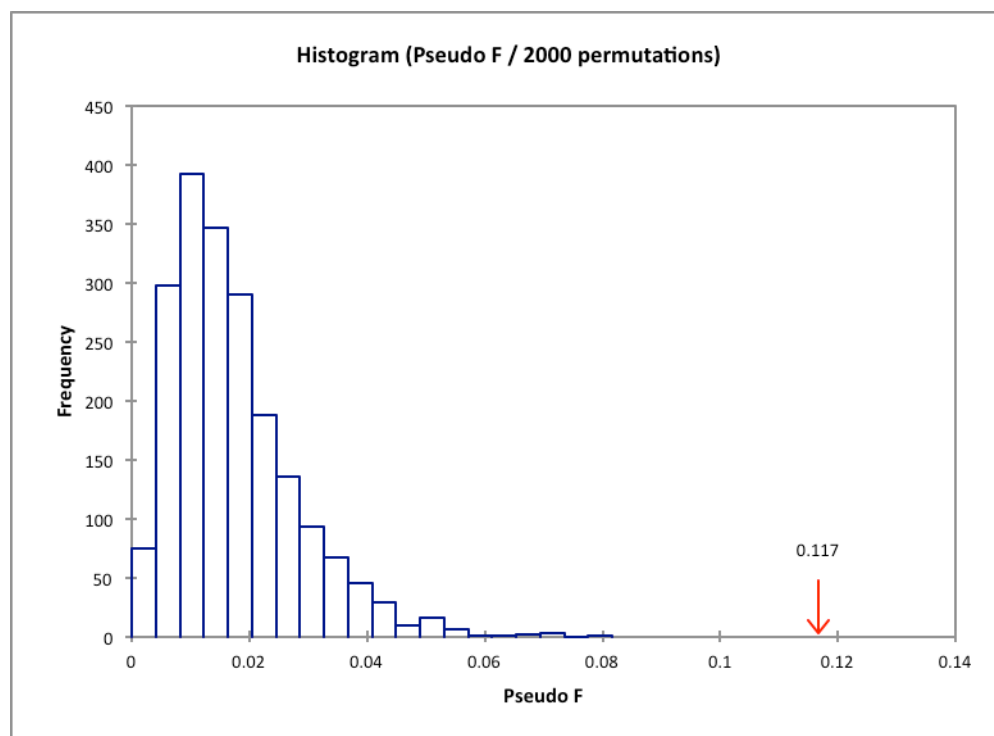


Figure 6.6. Histogram of permutation test of screenings 2014 vs 2015.

There was a very highly significant effect of the assessment period on the 8 variable dataset when considered as a whole, i.e. in a multivariate context.

Results of the permutation test:

Permutations	2000
Pseudo F	0.00000000
p-value	1.00000000
alpha	0.05000000

Table 6.10: Permutation Test of Villages (2015 vs 2014).

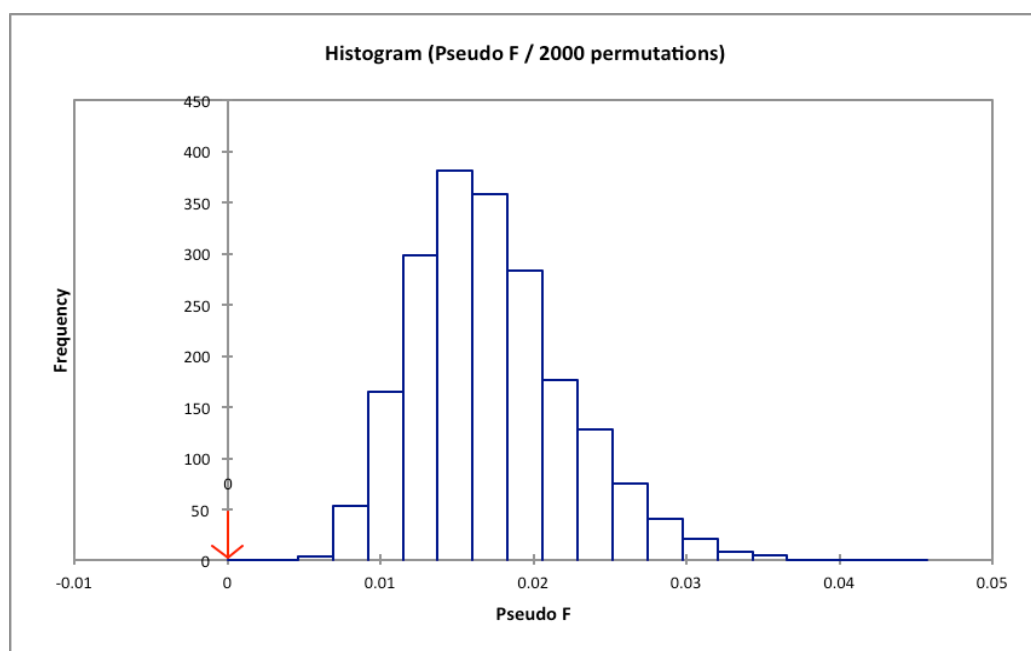


Figure 6.7. Histogram of permutation test of villages (2014 vs 2015).

No effect was observed for variations of villages tested when explored for their ability to influence the oral health status of the participants involved.

Results of the permutation test:

Permutations	2000
Pseudo F	0.02205958
p-value	0.24800000
alpha	0.05000000

Table 6.11: Permutation Test of Ages (2015 vs 2014).

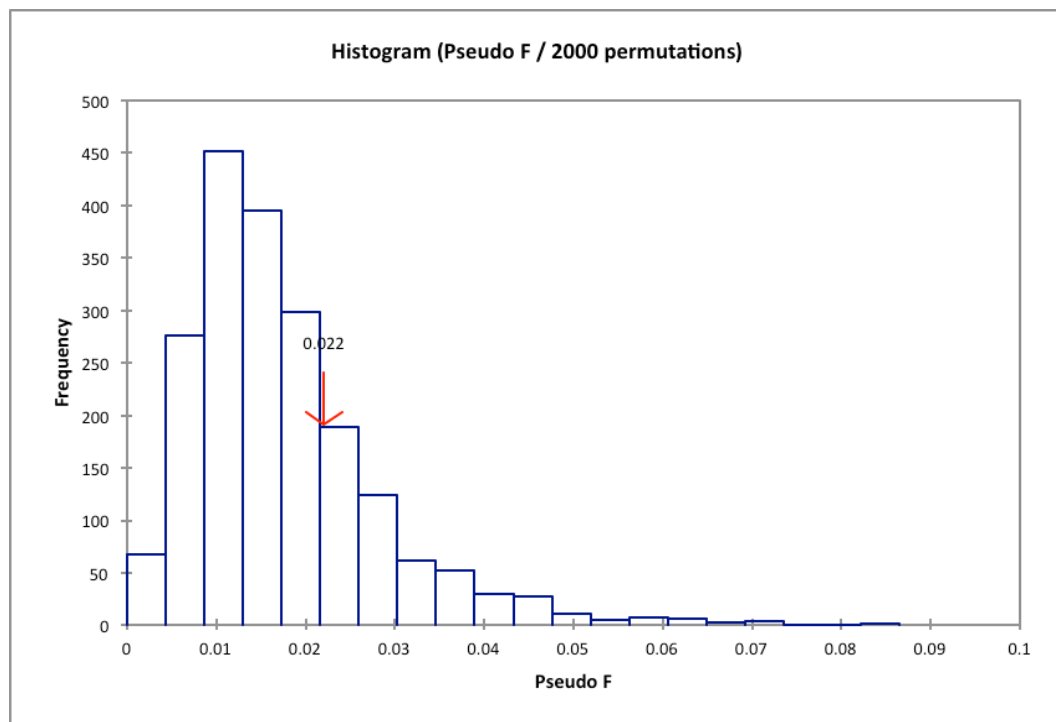


Figure 6.8. Histogram of permutation test of ages 2014 vs 2015.

Age variations not statistically significant, although the p value obtained for the multivariate influence of child identity (0.248) was not far-off from the minimum value required for this (0.05).

Results of the permutation test:

Permutations	2000
Pseudo F	2.92105684
p-value	< 0.000000001
alpha	0.05000000

Table 6.12: Permutation Test of Child Participant (2015 vs 2014).

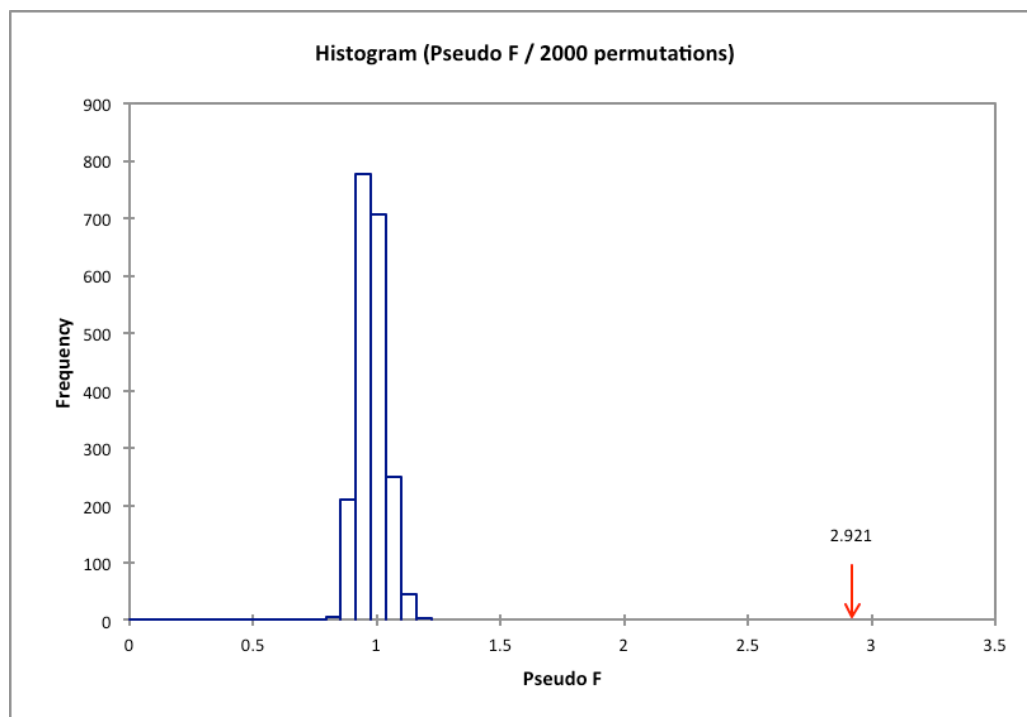


Figure 6.9. Histogram of permutation test of child participants 2014 vs 2015.

As expected, the child participant explanatory variable was found to exert a major effect on the oral health screening variables ($p < 10^{-8}$).

Overall, results considering permutations and ANCOVA analysis indicate an improvement in a decrease of oral disease in the children as a result of the OHAP (treatment) between 2014 and 2015 screenings, regardless of location and gender of the children. Differences in variance by age and by child are acceptable as the changes in primary teeth vs. permanent teeth vary by child as they age and by tooth eruption stages. This is an overall indication of the positive effective of delivery of oral health training programmes utilising the local NGOs and local community groups.

6.3 Principal Component Analysis (PCA)

PCA was performed on two experimental model systems, the first with all 8 variables incorporated (i.e. the primary teeth decayed, retained & decayed primary teeth, permanent teeth decayed, primary molar decayed, permanent molar teeth decayed, mixed dentition, missing teeth and visible calculus variables, Model 1), whereas the second was performed with only the 5 variables considered to be most relevant to this study, specifically primary teeth decayed, permanent teeth decayed, primary molar decayed, permanent molar teeth decayed and visible calculus (Model 2). In this manner, comparative evaluations could be made between the total 8 and limited 5 variable models developed.

6.3.1 PCA Eigenvalues of 8 Screening Variables

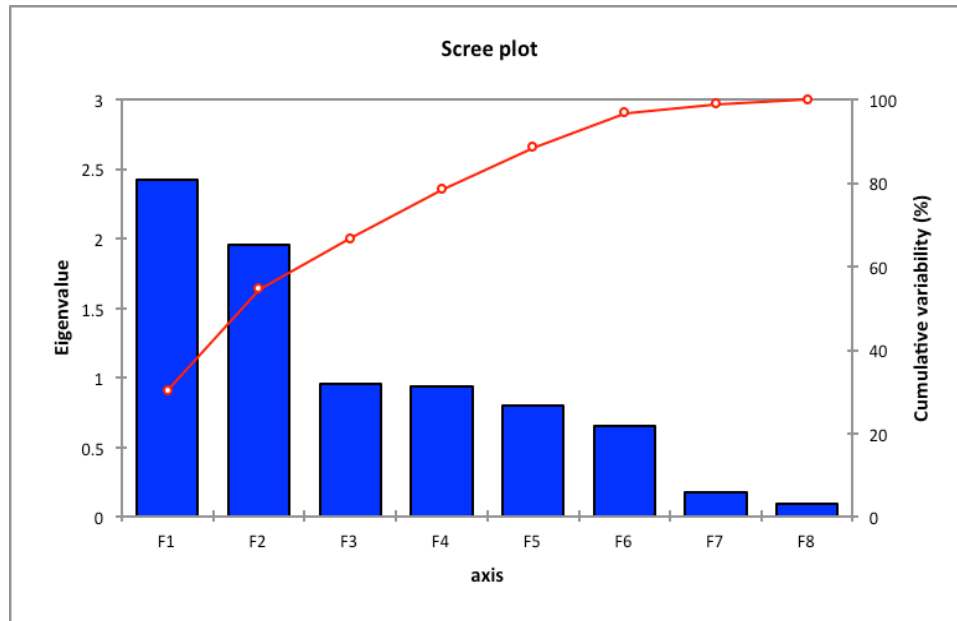


Figure 6.10. PCA scree plot showing the 8 variables that explain 100% of total variance of the screening data.

	F1	F2	F3	F4	F5	F6	F7	F8
Eigenvalue	2.41	1.95	0.96	0.94	0.79	0.65	0.17	0.09
Variability (%)	30.2	24.4	12.0	11.7	9.98	8.22	2.17	1.17
Cumulative %	30.2	54.6	66.6	78.4	88.4	96.6	98.8	100

Table 6.13: PCA Eigenvalue Factors, and their individual and cumulative variability contributions of the Overall Screening Data.

This PCA model contained a total of 4 major factors (principal components, PCs), which had eigenvalues (mean numbers of values per PC) of 2.41, 1.95, 0.96 and 0.94 for PCs 1, 2, 3 and 4 respectively. PC1 was significantly loaded positively with the primary teeth, primary molar and mixed dentition variables, PC2 positively with permanent teeth and molar teeth decayed variables, PC3 positively with missing teeth visible, and finally PC4 positively with visible calculus alone.

6.3.2 PCA Loading Plots of 8 Screening Variables

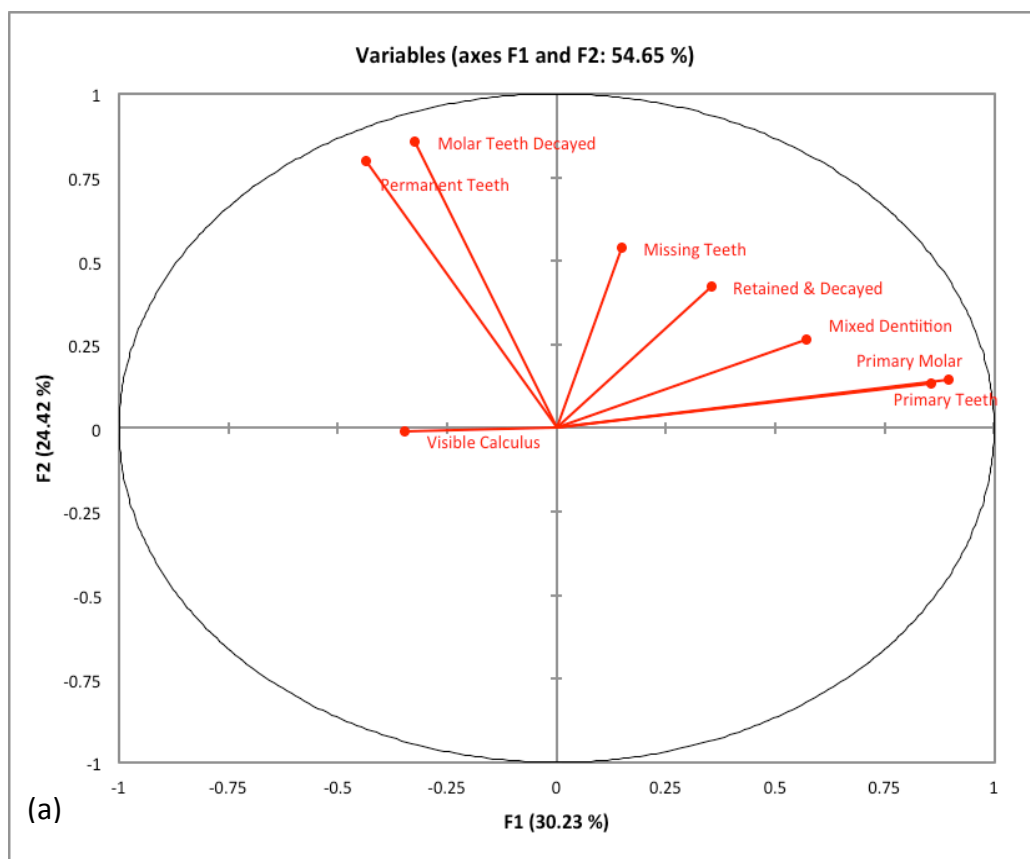
Highlighted in Table 6.14 are the multiple observed variables with similar patterns of response in the screenings associated with a latent (unmeasurable) variable. Children develop individually within their age groups, hence the mixed dentition is an unmeasurable variable. Both eigenvalues and factor loadings indicate a strong relationship of these complex variables for F1 and for F2. Both F3 and F4 are just under 1.0, and therefore these indicate that they are only explicable by contributions from only a single variable each. Indeed, F2 indicates an important relationship between retained and decayed teeth and existing primary molar teeth decay.

This can be problematic for the children later in life as newly erupting permanent teeth can be similarly affected. Retained and decayed teeth can block the eruption of newly-formed permanent teeth causing malocclusion, crowded teeth and occasionally missing teeth. Heavily decayed primary molars have a high bacterial influence on erupting permanent molars (6's) in view of new decay and bacterial loads on the teeth.

Factor loadings:	F1	F2	F3	F4	F5	F6
Primary Teeth Decayed	0.85	0.14	-0.40	0.18	-0.04	-0.14
Retained & Decayed	0.35	0.42	0.27	-0.25	0.72	-0.21
Permanent Teeth Decayed	-0.44	0.80	-0.27	-0.025	-0.026	0.11
Primary Molar Decayed	0.89	0.14	-0.295	0.189	-0.05	-0.03
Molar Teeth Decayed	-0.325	0.86	-0.25	-0.008	-0.025	0.10
Mixed Dentition	0.57	0.26	0.45	0.08	-0.05	0.625
Missing Teeth	0.15	0.54	0.55	0.13	-0.43	-0.425
Visible Calculus	-0.35	-0.01	0.09	0.89	0.29	-0.015

Table 6.14: PCA Loading Plot of Screening Variables

The following charts (Figure 6.11) show placement of the factor loadings of each variable for combinations of (a) F1 and F2, (b) F2 and F3, and (c) F2 and F4. The positive relationships between the variables in the upper right quadrant in (a), i.e. missing teeth, retained and decayed teeth, mixed dentition and primary molars and primary teeth, show similar relationships of the variable along these dimensions, and negative relationships to those in the upper left quadrant (permanent teeth and permanent molars) and lower right quadrant. However, visible calculus was negatively correlated with F1, although this cannot be considered as a significant contribution since the loading score vector was only -0.35. This is expected since visible calculus is a separate oral disease unassociated with decay.



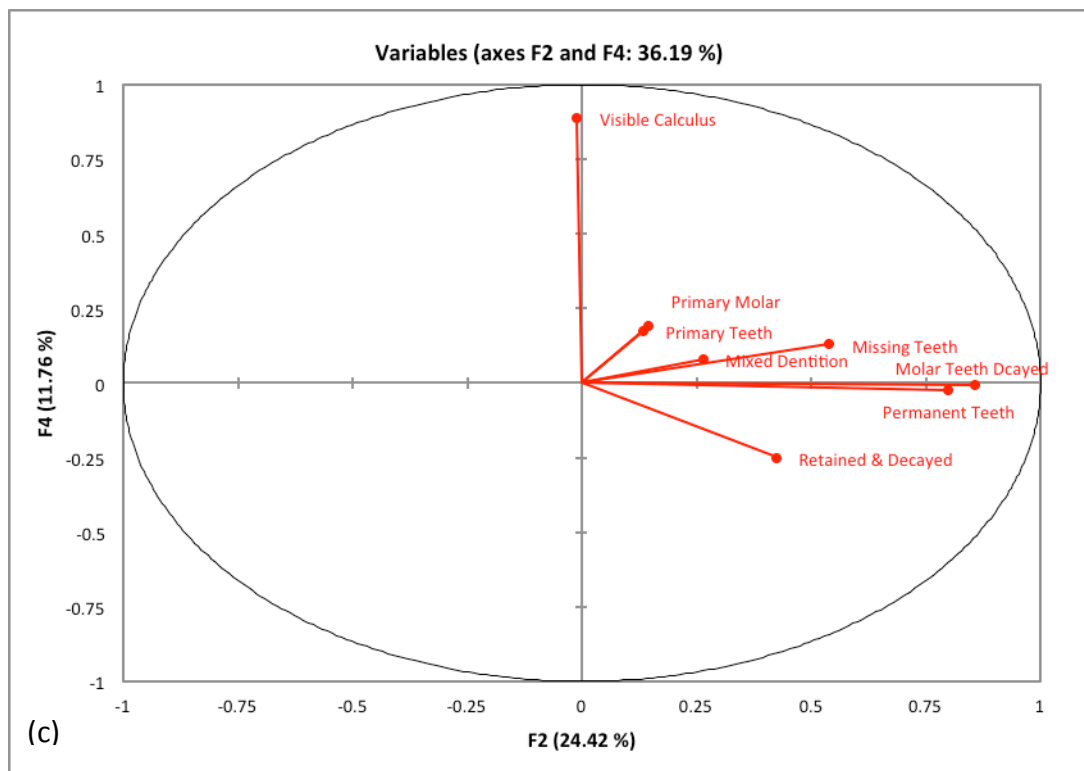
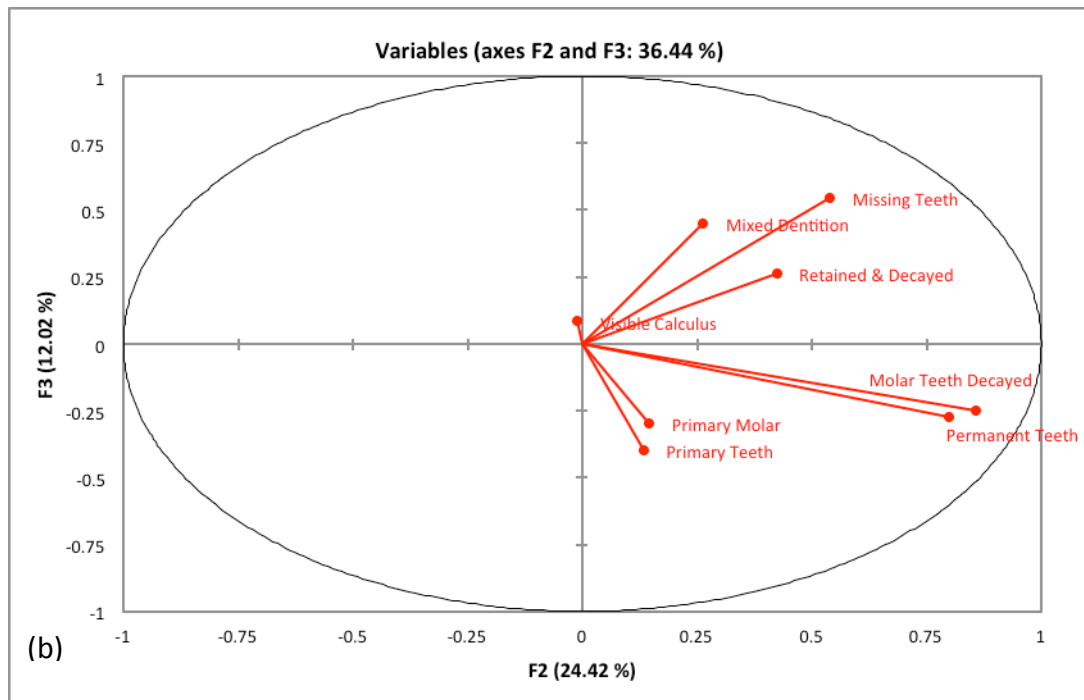


Figure 6.11. (a) PCA loading plot of screenings variables F1 and F2 (accounting for 55% of the total variance); **(b)** PCA loading plot of screenings variables F2 and F3 (accounting for 36% of the total variance); and **(c)** PCA loading plot of screenings variables F2 and F4 (also accounting for 36% of the total variance).

6.3.3 PCA of Only 5 Major Screening Variables

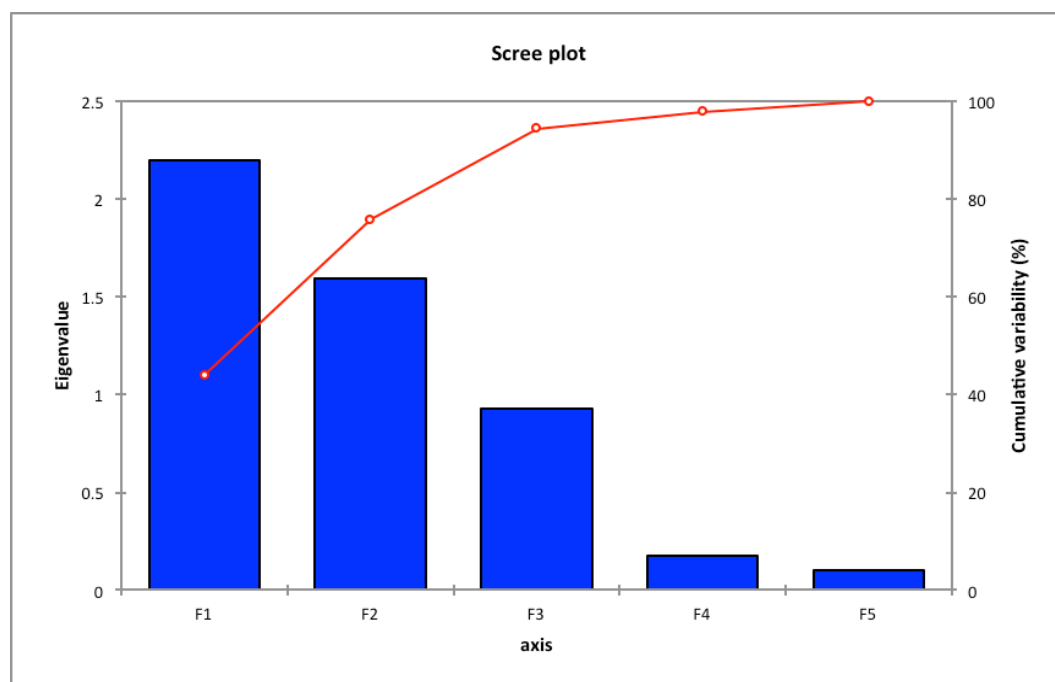


Figure 6.12. Scree plot of PCA Eigenvalue (mean number of variables) for each of the first 5 PCs isolated.

A scree plot arising from the principal component analysis of the entire experimental dataset (Figure 6.12) indicated that only three major factors were isolable, the first and second (PC1 and PC2 respectively) loaded with two variables each, and the third (PC3) with only one. Eigenvalues for PCs 1, 2 and 3 were 2.20, 1.59 and 0.93 respectively (Table 6.15).

	PC1	PC2	PC3	PC4	PC5
Eigenvalue:	2.20	1.59	0.93	0.18	0.10
Variability (%):	43.99	31.85	18.56	3.51	2.10
Cumulative %:	43.99	75.83	94.38	97.90	100.00

Table 6.15: PCA Eigenvalues of 5 Major Variables

Eigenvalues (mean numbers of variables per PC) for each of the PCs isolated from a principal component analysis of the complete experimental dataset. Also shown are the percentages variabilities for each PC, together with their cumulative variability.

Contribution of the variables (%) after Varimax rotation.			
PCs:	PC1	PC2	PC3
Primary Teeth Decayed	49.41	0.19	0.64
Permanent Teeth Decayed	0.81	49.14	0.13
Primary Molar Decayed	49.16	0.37	0.60
Permanent Molar Teeth Decayed	0.02	50.20	0.07
Visible Calculus	0.60	0.09	98.55

Table 6.16: Percent Contribution of Variables after Varimax Rotation

Percentage contributions of each variable to the three major principal components isolated from principal component analysis performed with Varimax rotation.

Squared cosines of the variables after Varimax rotation.			
PCs:	PC1	PC2	PC3
Primary Teeth Decayed	0.94	0.003	0.006
Permanent Teeth Decayed	0.015	0.90	0.001
Primary Molar Decayed	0.93	0.007	0.006
Permanent Molar Teeth Decayed	0.0003	0.92	0.001
Visible Calculus	0.011	0.002	0.99

Table 6.17: Squared Cosines of the Variables after Varimax Rotation.

Squared cosines of the variables following varimax rotation. Values in bold correspond to the PC for which the squared cosine is the greatest for each contributory variable.

Principal component analysis (PCA) performed on the entire dataset using Varimax rotation clearly segregated the five available variables being; decayed primary teeth, permanent teeth, primary molars, permanent molar teeth, and visible calculus into

three orthogonal (uncorrelated) components (factors). The first of these contained highly significant positive contributions from the decayed primary teeth and primary molars, as expected, whereas the second contained highly significant positive contributions from the correlated decayed permanent teeth and permanent molar teeth variables. However, the third PC (PC3) only contained a highly significant contribution from the visible calculus variable, which serves as a significant precursor to the development of periodontal disease; this variable is not expected to correlate with any of the other four variables included in the study since these are considered to be independent of it.

Overall, the results acquired from PCA analysis of this reduced (5 variable) dataset are fully consistent with those acquired from the full (8 variable) one, i.e. the primary teeth decayed and primary molar teeth decayed variables loaded strongly onto the same PC, the permanent teeth decayed and permanent molar teeth decayed loaded strongly onto an alternative (orthogonal) PC, and finally the visible calculus variable loaded onto a further orthogonal PC alone in both models. These two approaches confirmed the robustness of the multivariate analysis strategy employed.

7. Discussion

Promoting and creating oral health awareness programmes can be challenging to implement, especially in developing and underserved communities. Improvement of basic living essentials such as clean water, shelter, food, access to education for children, and improved livelihoods are vital to the survival of these populations. However, in these communities, various worldwide studies have shown high levels of dental disease, a general lack of oral health knowledge in parents and caregivers, and limited or no access to dental care. As communities improve and develop socially and economically, dental decay in children is increasing rapidly.

Dental disease in children is ranked as one of the highest epidemics of the world, succeeding asthma, and is rapidly increasing.^{7,8,12,31,92,93} Indeed, severe oral infections in children can not only cause high levels of swelling, pain, and eventually tooth loss, it can also lead to much severer conditions such as increased malnutrition in view of an inability to chew well, low body weight from undernourishment, weaker immune systems, other head and neck infections, and even death.^{9,12,14,70,71,94,95}

In populations with limited access to dental care and education, dental disease in children is a serious issue. It is essential that education about oral disease prevention and effective oral care skills be incorporated into health programmes within developmental community projects. Besides involvement of dental institutions and governmental schemes for oral health promotion, studies continue to recommend and promote the need for community-based approaches to oral health awareness and

educational programmes.^{5,50,79,96-98} However, documented research of actual implemented programmes are scarce, and those that are available are mostly school-based programmes *versus* this 'grass-roots' community-based one.

The major aims of this exploratory study were to seek evidence for the utilisation of local non-dental NGO teams and local participatory groups, i.e., women's self-help groups and children's parliament groups, for the implementation of an oral health promotion and awareness programme, from a strictly grass-roots level approach.

This research programme first set out to determine if a change in parents' mind-sets regarding their children's teeth and oral health could occur within a one-year period, through the instructions of local community-developmental groups, as measured and monitored through questionnaires. Secondly, the researcher set out to detect if, within a one-year period, oral health changes in the areas of reduction of visible decay and visible calculus in primary and permanent teeth could be observed amongst screened children. Finally, it sought to assess each of the test groups to determine if any within a particular group had more influence on the villagers. Each aspect of the study will be reviewed below.

7.1. Questionnaire Evaluation

The questionnaire set out to gather opinions and baseline perspectives of the local villagers regarding their views on oral health before and after implementing the OHAP

training course. The questionnaire contained a series of questions pertaining to the general oral health perspectives and practices of the local tribes, the attitudes towards daily dental hygiene practices and care of children's teeth, and viewpoints regarding tribal needs and priorities compared to the importance of children's teeth. The same questionnaire was provided at the initial phase, and also at a one-year interval, to determine if there was a mind-set change after the OHAP. Questions, which had a total of more than 5% incomplete answers, were eliminated from the results. Six key questions were chosen for analysis, and these are discussed below.

7.1.1 Analysis Question 2: Importance of children's teeth

In a developmental community, oral health generally tends to be of a low priority when compared to those of other survival issues such as clean water, food, income, and access to education. Question 2, "How important are children's teeth?" was asked to determine if it was possible to measure the overall general opinions of the parents regarding children's teeth. This was the first type of interactive questionnaire in which the villagers/parents had participated in, so the questioning and answering processes could have been misinterpreted. Most parents in developing communities are illiterate, hence translation of the questions were verbalised. An interviewers' influence could have exerted an effect on the answers derived therefrom. Also, traditional approaches to community development was to make an assessment via an NGO team, an action would be recommended, skill-sets would be instructed and taught to implement appropriate tasks or proficiencies. Participants expressing their

own opinions could have been perplexing at first and difficult to comprehend.

However, the question was successful in confirming that overall, the parents questioned did, in general, value the oral health status of their children and that the shift from 'important' to 'kind of important' answer could reflect that parents felt the problem was now being controlled.

7.1.2 Analysis Question 4: Frequency of cleaning children's teeth

Question 4, "When should children clean their teeth?" was asked to determine which daily habits are being practiced, and also what is the general opinion of parents regarding the frequency of cleaning (brushing) children's teeth. The word 'cleaning' was used since the practice of oral hygiene for children is not a priority. Toothbrushes and toothpastes are available in the local village shop, but are purchased mainly for adult usage and are more expensive than a tree branch, which is available at no cost.

This question is relevant to the study, since we note that the participants of the OHAP have changed their mind-sets through the educational programme, and now accept that both morning and evening toothbrushing episodes are more important for children's oral health, than just once in the morning or not at all, as previously practiced. Also, the participants learned the importance of brushing 'gums', and why this is essential for oral health since this practice had not been previously performed, as Ayurvedic Medicine recommends against it.⁵⁵

7.1.3 Analysis Question 5: Tongue Cleaning vs. Teeth Cleaning

“Is cleaning your tongue more important than cleaning your teeth?” was asked in question 5 to determine a cultural custom and belief. Local Indian custom follows cleaning your tongue in the morning as a general hygiene practice according to Ayurvedic recommendations.^{54,55} This question was important to establish if a local custom could be influenced, and also if OHAP training could help them understand that cleaning teeth is more important than that of the tongue, (which is secondary), for oral health. Responses revealed answers reflected a positive perspective towards cleaning teeth at first, but declined a year later to reflect the local custom, i.e. that cleaning the tongue is more important. This result could arise from local influences or translation challenges of the question, or misinterpretation of what the question meant to ask. Previously, in Western cultures, brushing, scraping, or cleaning the tongue was not readily known or practiced. It is a taught skill, that has proven effective when aiming for complete oral health, and it is a necessary daily practice for diminishing bacterial loads in the mouth and on the tongue, for improved oral health, and to decrease further periodontal pathogens. It has also been accepted and proven to reduce halitosis.^{47,48}

Misunderstanding the meaning of the question could have effected the understanding that cleaning your tongue is not only a daily habit for a healthy mouth, but also for general health, common to Indian practices. Limitations of this question were in the translation of the meaning of the question and manner in which it was written.

Suggestions for re-introducing this question again would be to specify tongue cleaning

in conjunction with teeth cleaning and oral health practices only and not how it relates to general health at first. However, both are equivocal concerns regarding the requirements for an overall healthy mouth.

7.1.4 Analysis Question 10: Interest in learning about children's teeth

Despite all of the other community development educational programmes and skill-sets available that underserved populations must learn, (in order to enhance sustainable development and practices within their communities), question 10 asked, "Would you like to know more about children's teeth?" This question was put to participants to determine if parents were remotely interested in learning about their children's teeth, and also if there could be an increased attendance on an OHAP course. Results did show an overall interest to the OHAP with an established increase in participation of the questionnaires a year later. These 'new' parents were neither present during the initial phase of the OHAP, nor interested in participating. However, this increase in participation during the follow-up phase shows that despite many other daily community issues to improve, such as enriched nutrition, added sources of food, improved livelihoods, child protection, education, and general health practices, parents are still interested to learn about their children's teeth and participate in educational programmes to do so. Moreover, 118 extra questionnaires were completed, from additional parents joining the OHAP who were also not present during the initial phase. These positive unexpected findings were not included in the dataset acquired, in view of missing comparison data from Phase 1, however, this

observation provides support for the original question of parents showing a growing interest in learning more about their children's teeth.

7.1.5 Analysis Question 13: Everyday Needs

Question 13, "Which is MORE important: choosing between food, shelter or family?" (designed in the form of pictures, for improved comprehension of the question in an illiterate society), was primed to determine the local values and opinions of the everyday necessities of the participants. One of the main problems in underserved communities is malnutrition and the availability of food. Most tribal communities are undernourished, and sources of food can be limited and therefore are high priority needs, especially for children. Shelter can also represent a major challenge, since most houses are built with reeds, branches, trees, and mud located in the area. When the rainy season appears, many families lose shelter and belongings, in view of floods and rain washouts. Families are very important and tightly bonded to each other and their communities, which they live closely amongst themselves and cooperatively, help each other in times of need. This question focused on gathering an understanding of the most important requirements of such tribal communities and their perceived level of importance. As anticipated, food was considered the most important requirement within the community.

7.1.6 Analysis Question 14: Sweets vs. Children's teeth

With the availability of sweets (hard sweets and sugary drinks) through local village shops, many parents give their children two Rupees (IRP) a day to spend on treats.

Many parents feel it is important to give a little something special to the children, in the form of sweets (as explained by the local NGO staff), and it is also a form of pacification, when the child 'acts-up' or is having a temper tantrum. Also, sweets and sweet tea are interpreted as a source of food, which is the main concern for underserved communities, as observed in question 13. A cow is also an important entity since it supplies food, in the form of milk, and it can also serve as a means of income through the selling of the milk. It is also considered sacred in Hindu beliefs.

Question 14 sought to generate a response to "Which is the LAST (least) important: choosing between sweets, children's teeth and a cow", in the form of a picture, for improved comprehension of the question in an illiterate society. The question was written as 'LAST' important for simple translation and interpretation of the meaning of the question, since 'least' might not be understood. Results showed that those who placed children's teeth as least important, changed opinions after attending the OHAP course showing that the participants learned to value their children's teeth rather than sweets. This was a significant positive result and outcome of the OHAP.

Overall, the questionnaire had a positive result in showing that an OHAP course could influence and change a mind-set with regards to the oral health status of children.

More importantly, it showed that working with NGO teams for the implementation of such questionnaires and oral health awareness, and also informational programmes, can be executed smoothly and effectively. This supports a positive outcome of the original aim and question; i.e. if an oral health awareness course could be

comprehended and understood when implemented via a 'grass-roots' approach using non-dental local community development groups as trainers and teachers.

7.1.7 Questionnaire Strengths, Limitations and Suggestions

Although the questionnaires did provide useful information regarding local oral hygiene practices and perspectives, it is important to address limitations and make suggestions for improvement for future questionnaires involving these groups. One limitation could be attributed to the illiteracy of many participants. The participants were read the questions out loud by a local NGO staff member or local translator, some being adolescent school children of the CP group who could read and write. Translation and answering of the questions could have been influenced by a "response bias".⁹⁹ This type of cognitive bias reflects the opinion of the translator either in misinterpreting the questions and/or translating the question with a leading question. Often, in such NGO community development programmes, participants want to please the organisation donating time and money to such projects. Community members also could have a tendency to conform to the authorizing body, aiming to please. Another limitation could be in consideration of the overall sample size and how the process was implemented. The questionnaires were completed at various stages during the day, when the parents arrived to bring the children for the screening follow-ups, and not all at the same time. This could have escalated the 'peer-to-peer' influence, which could have altered the questionnaire answers. However, this influence is a desired effect when promoting this type of 'grass-roots' approach to community development

programmes such as this, so the questionnaire and answers served to be significantly valuable and one of the strengths of this study.

Suggestions for future questionnaires within community development programmes, in which subjects are illiterate, could be via a direct interview method instead of a written response. A more comprehensive overview of the questions could be provided in a visible form, if indeed it applied, rather than in written form and limited to five questions. Participants could be streamlined into specific sub-groups focusing on more intimate and controlled groups, instead of larger ones, but this would involve a considerable increase in the amount of time that would be required to gather such questionnaire data. Moreover, questions could be developed with a local inhabitant who speaks the language, and could also formulate the questionnaire according to local beliefs and mind-sets, avoiding biases and translational misinterpretations. Smaller groups could also provide another aspect of open discussion of opinions, problems, and concerns. Questions could be directed towards common problems associated with children's teeth and oral health, and consequences resulting from dental pain, especially those common to children. Once the parents acknowledge a problem exists, they could be more open to a solution on how to resolve it. This approach would also be more suited to fit the NGO 'self-help' approach concept, and focuses on the initiation of self-realisation and ownership of the problem, with the intent of self-motivation and the implementation of a lifestyle change.

7.2 Evaluations of Dental Screenings

7.2.1 Analysis of Dental Decay 2014-2015

Studies have also shown that highly decayed primary molars have a probability of influencing erupting first permanent molars thus increasing the rate of caries onset.¹⁰⁰⁻¹⁰⁶ This would support the overall Phase 1 findings of this study (Appendix 10.3(a)). It also supports various other studies, which have shown that children inhabiting underserved populations in India under the age of 14 have a mean average of four teeth decayed, primarily in primary and permanent first molars.

This study did not elaborate on the exact reasons for decay, nor focus on various levels of this decay, nor the times that they occurred, since this was not the focus of this study. It did, however, confirm a high visible presence of decay and a limited knowledge of oral hygiene practices among these rural tribal villages. It has also appeared that the OHAP has initiated the frequency of toothbrushing and improved daily oral hygiene habits in children, and bacterial loads on these teeth have been reduced, thereby reducing some of the onset factors (discussed in section 2.1), of conditions referred to as Early Childhood Caries (ECC).⁸²

This is to be expected since once the primary teeth are decayed and not treated, they would not have changed, and nor would a considerable reduction in decay levels be observed. However, the slight decrease in decay of primary teeth could have arisen from arrested decay, which may emanate from improved oral hygiene practices and

toothbrushing with fluoride toothpaste, and/or it could also be associated with the exfoliation of the decayed primary teeth. This being the case, together with the eruption of the new permanent molars, the permanent teeth were shown to display a significant decrease in new decay, which is a desired outcome of the OHAP.

Overall, the study supports and confirms a positive outcome of the original study question; i.e., if a decrease in visible decay could be observed after an OHAP course taught by local non-dental trainers and NGO teams, through showing a decrease in visible decay per child.

7.2.2 Analysis of Visible Calculus 2014-2015

This study revealed that visible calculus in this population of children was reduced within a one-year time span. This decrease indicates a similarity to other research supporting that improvements in daily oral hygiene habits, frequent toothbrushing and appropriate oral care, will reduce plaque and biofilm build-up, and also improve oral health status in these children.^{37,38,43} There is also a coincidental chance that correct and effective toothbrushing could break-up the softer deposits, which are present at the primary stages of dental calculus formation. This 'breaking-up' of the soft deposits has not yet been scientifically documented, but could serve as a basis for a future study on this subject.

To gather insight into which village showed the greatest oral health changes, i.e. decreased incidence of oral diseases, a comparison per village is discussed in the next section.

7.3 Comparisons Between the Villages Involved in the Study

7.3.1 Influence of Village Location and Access

All villages were located in a remote area localised around the Indian town of near the larger city of Ulhasnagar and within the State of Maharashtra (Figure 3.1). This area is an estimated 2 hour drive north-east from Mumbai. The entire area is in the process of infrastructure stabilisation and economic growth. Many frequently traveled roads are in the process of continuous development, and are being updated, paved, and improved. Also, the main road which passes many of these remote villages is the main pathway for a bi-annual 'pilgrimage' for the local Hindu temples. Access to these areas were previously via narrow, remote, and bumpy dirt roads which could take many hours to reach. Now, through these road improvements, communities which were once very remote and difficult to access are now easily accessible, with the exception of Chon. The villages of Kuraden, Lavaliee, and Kurdapada are located directly on the main paved road, and have a daily stream of passing traffic. Chon is the only village within this study which is located several kilometers off the paved road in a remote location, and does not have passing daily traffic.

7.3.2 Livelihoods and Sources of Income

The main source of income for these poorer rural populations are mostly farming and raising livestock such as goats, chickens, and cows. Some of the villagers also have access to work in brick making, which is a common trade in this area. Often, older children are forced into working in the farms rather than attend school; this is for the purpose of generating more income for meeting the needs of the family. Moreover,

some school fees can cost more funding than that which a worker produces, and are sometimes not affordable for underserved populations. Therefore, rather than send children to school, they are forced into labour or choose to work instead of going to school.^{107,108} Not attending school can expose children to environmental and social risks, reduce social dialog and interactions, hinder mental awareness levels and social development, and diminish decent work opportunities in the future, which an education could, at least in principle, provide.¹⁰⁷ The NGO community development programmes assist the villagers in establishing farming groups for community support and growth, and also assist in the development and teaching pathways for additional alternative and more sustainable and achievable means of income within the individual areas and communities (Table 7.1). Its focus is to promote and enhance incomes, with the emphasis of sending children to school rather than into the work force.

Means of Income or Livelihoods per Village

Village	Livelihood	Karunya Intervention
Kuderan	Farming and animal husbandry	Formation of farmer's and self-help groups, training on organic farming, good governance, health & hygiene, etc. Promotion of water and soil conservation.
Lavallee	Farming and animal husbandry	Formation of farmer's and self-help groups, training on organic farming, good governance, health & hygiene, etc. Promotion of water and soil conservation.
Kuradpada	Farming	Formation of farmer's and self-help groups, training on organic farming, good governance, health & hygiene, etc. Promotion of water and soil conservation.
Chon	Farming and work on brick kilns	Formation of farmer's and self-help groups, training on organic farming, good governance, health & hygiene, etc. Promotion of small businesses.

Table 7.1. Source: Karunya Trust Statistics on Ambernath Tribal Village Livelihoods, and proposed interventional targets.

7.3.3 Comparisons per Village of Tooth Decay Changes from 2014-2015

On comparing individual village outcomes, results show that the village of Lavaliee had the most overall decrease in decay (Table 5.5). Lavaliee was the second village to receive the OHAP training which was given by the CP group (participants were mostly children and young mothers). The village had organised a small entertainment programme of singing and dancing before the OHAP, which appeared to be organised similar to a special event. The positive results of the screening could arise from the villagers participating and earnestly partaking in the programme, and hence choosing to participate. This could have enhanced motivation for implementation of the OHAP, and the methods taught were then supported and reinforced.

The increase of decay in the primary teeth in the Kuderan village from 2014 to 2015 could arise from the introduction of sugary drinks and other forms of accessible sugars not previously available before the study commenced. The increase in primary decay could also be attributed to the increase in economic advancement, as reported by HCDI. Indeed, it was reported that this village has had great economic gain within the year of this research programme. With individual economic gain, disposable income is available for additional 'treats' for the children. Also, with more demand, the local shop can now sell more items, and a larger selection of sweets are available. As discussed above, the advancement within the community development project, and achievement of enhanced economical growth, has indeed increased incomes. Customary gifts of a few Indian Rupees for sweets, are rewarded to children

for performing chores or doing well in school. Additionally, the provision of sweets in order to calm small children's 'temper tantrums' is also common, as is often the case in Western cultures by the purchase of a 'treat' for the child. Hence, increased access to sweets may indeed influence the small increase in tooth decay of the primary teeth observed, though this was not statistically significant. The exact reasons for this were not established, but this may represent a subject for future research.

However, despite an increase in primary tooth decay in Kuderan village, the permanent teeth had the highest reduction in decay amongst all four villages in one year, especially in permanent molars demonstrating that the WSHG had the most effective results presenting the OHAP. The villages of Kuradpada and Chon showed similar results of decay reduction in primary teeth and permanent tooth decay (Table 5.5).

Kuradpada and Chon were the last villages to receive the OHAP. Kuradpada village received the OHAP from the NGO team, and Chon through a co-operational mix of CP teams and NGO staff. Despite positive statistics for reduction in the incidence of dental decay for these two villages, they were not as high as those observed with Kuderan and Lavaliee. However, they did exhibit the greatest decrease in observed visible calculus. These results are not simply explainable, however, it was observed that the local school teacher had a greater level of involvement in these village than that noted in the others.

Overall, one of the strengths of this study is that it showed a general decrease in decay observed in all four of the test villages. Permanent first molars showed the greatest reduction of overall decay, which is a desirable outcome. It is to be expected that primary teeth would not have greater decay reductions, since the range of test subjects were aged from 2-14 and most primary molars would still be retained within the single year of the study. Notwithstanding, this reduction could arise from the exfoliation of decayed primary teeth, which were then no longer present at the follow-up screening. The new eruptions of permanent first molars without decay were then present, in addition to arrested decay in already existing permanent first molars. These results were positive, and were one of the primary aims of this study. In any case, a desired reduction of decay in the newly-erupted first permanent molars, and arresting of the decay in the existing permanent molars have indeed shown a positive outcome for improved oral health through the cooperation of local non-dental groups for oral health awareness and promotion.

7.3.4 Limitations of Baseline Screenings

Screenings of the school age children within developing communities requires careful planning. Experience has shown that organising such OHAP events during school holidays might be the most suitable time to observe a majority of children in that village, rather than during school terms. It is also important to consider that the local perspective remains that school is a more valued priority than oral health, since the foremost concerns for these populations are health, education, and nutrition.

This study has emphasised the value of a close liaison and collaboration with the local NGO organisers and teams, to determine the most effective and efficient time for an OHAP to be delivered. It is believed that this was a key factor for achieving a high level of involvement and sustainability of the improvements. In addition, organisers should appreciate that NGO directives can be altered during the entire community development project, and that oral health falls below basic survival needs during specific timeframes of their projects. Furthermore, the progression of decay and the time difference required between existing primary decay to form subsequent, newly-developing decay in erupting permanent teeth can also affect these outcomes, and this is also an area that should be further researched within these populations.

In a systematic Cochrane Review (Silva *et. al.* 2016), community-based population-level interventions for promoting child oral health were reviewed. It found that oral health education without supporting toothbrushing practice and basic treatment only gave limited results.⁹⁶ Hence, this study integrated teeth cleanings (oral prophylaxis), and basic restorative treatments for all participants during the follow-up in Phase 4, as continued emphasis of the importance of oral health for children. Future research integrating basic treatments together with OHAP during Phase 1, at the beginning of the study, is suggested.

7.4 Oral Health Awareness Programme Evaluation

Most research involving poorer populations tends to focus on decay levels, a lack of oral hygiene education, and the requirement for oral health programmes. However,

little has been documented with regard to the actual application of a programme within these communities, and using non-dental personnel to deliver an OHAP course.

The “Fit for School Programme”, a four-year, ‘top-down’, school-based programme in the Philippines,² has been the most detailed and elaborate programme to be implemented to date; however, it focuses on a school-based approach with dental professionals and was not one that involved non-dental, local NGO teams and community groups utilised as instructors of the OHAP.

Again, using a school-based approach and dental professionals, phase 2 of the “Live Learn Laugh” programme of the World Dental Federation (FDI) and Unilever Oral Care, implemented a global approach to oral health education and decay prevention over a one-year period involving nine low and middle-income countries, implementing a toothbrushing programme with fluoride. Results varied within each country amongst age groups under 12 years, yet still the study stressed that a ‘whole-population’ approach is required for early caries prevention.¹⁰⁹ This supports the suggestion that limitations to a school-based approach is that oral hygiene practices are standardized during school terms, but when children return home for vacation breaks, such reinforcement is not usually continued if the parents have not been involved in the primary dental education programme.

The WHO recently published a very comprehensive manual entitled, “Promoting Oral Health in Africa”, with proposals of a ‘top-down’ approach to OHAP and suggestions

concerning how exactly to organise such projects, but does not provide evidence from previously implemented programmes.¹¹⁰ However, systematic reviews do support evidence of successful presentations of oral care courses performed in schools, day cares and elderly homes, and also one in a community-based setting in India.¹¹¹ Other studies focusing on oral health education have shown positive results supporting oral health awareness and educational programmes, through influencing change regarding an increased level of dental knowledge, improved daily oral habits, and in some cases, a decrease in oral pain.^{111, 1-5} Therefore, although we are aware of the positive effect of OHAPs programmes, the question is whether they are sustainable over longer periods of time, and also which methods of delivery are the most effective within poorer populations, who require it the most. Moreover, the question of the application of these programmes cross-culturally also arises.

This study showed a one-year sustainable outcome of an OHAP through an overall decrease in visible dental decay and the onset of calculus build-up. Erupting permanent first molars presented less decay after a one-year period, and some with decay showed signs of arrest. The classifications and levels of decay were not recorded, since this study was not based on an exploration of the complete epidemiology of decay, its onset, and classifications. It sought only to recognise visible decay, in a remote setting, in areas void of a dental clinic and equipped with technical dental facilities, using a large vulnerable population of children who had never had their teeth examined before, let alone observed Western foreigners with lighter skin. This in itself was sufficiently challenging to gain the trust and cooperation of some

children and parents without them feeling as if they were being harmed, exploited, or caused any pain. However, once observing that this programme was a benefit to them, and the health of their child was in the best interest of the programme, they openly participated.

Another visual assessment strength of this study revealed less plaque and food debris, although this was also not recorded and analysed, since this would be a more extensive study involving more time and the use of disclosing solutions and radiographs, which are not suitable for application in a rural setting. Future studies concentrating on classifications of caries in smaller sample sized groups, within these populations, are therefore suggested.

Children were brushing at least once daily, with many brushing twice daily. Local teachers commented that since the initial program was held, there had been a decrease of dental-related absenteeism at school. Moreover, teachers had noticed less halitosis in the children, although this is only hearsay and not scientifically proven nor observed and recorded, in this study. Parents who were neither able nor interested in having their children participate in the initial programme were present during the one-year follow-up, as documented by the extra-completed questionnaires. Nevertheless, it is an important observation regarding the acceptance and effectiveness of an OHAP course taught by foreigners and led by local non-dental groups and NGO teams.

This study has also shown methodology models created for health education and research involving planned behaviour and reasoned action would not be appropriate within such communities and the need of adaptation or creation of a specific methodology to fit the intended research aims would be more appropriate, as previously discussed in section 3.1. However, variations of PRA and TPB methodologies could be introduced in future research involving specific groups with smaller established sample sizes, such as in oral health for pre/post natal educational programs for new mothers or follow-up evaluations.

7.4.1 Comparisons of the ETGs

Villagers under NGO guidance are already in a changing environment, an observation indicating that cooperation can be higher in a community-based setting rather than in a school-based programme. Furthermore, utilising a 'whole population' approach, and involving local non-dental groups as trainers, has shown to be effective.

The ETG groups of established Women Self Help, Children Parliament (adolescent children), and the NGO groups were motivated in participating in the training session, and appeared to enjoy the programme. Each of the villagers had participants present during the OHAP training sessions for the ETGs. The WSHG-trained Kuderan village and the village of Lavaliee received the CP group as trainers. The CFCD team trained Kuradpada village and Chon village received the benefit of a combination of CPs and CFCDs as trainers.

The results acquired show a general improvement and impact on each village, with some slight varied differences. The WSHG group showed the most improvement regarding decay reduction in permanent first molars, yet had a slight, non-significant increase in primary decay (Table 5.5). This result could arise in view of the WSHG group being the first of the groups to implement the training in the village of Kuderan. Perhaps an understanding how the programme should flow was not as clearly understood as it was later in the week with the other groups. Additionally, most of the WSHG are illiterate, and the CFCD team had to assist the WSHG team during the OHAP. The influence of which group should present to which village was not manageable by the research team, since this was organised in advance via the NGO team, in view of logistics and the availability of the ETGs. It also could also arise from an easier access to sugary drinks and sweets via the local shop, which was not available before the study began as discussed in section 7.3.2.

For future research, it is suggested to train the CFCD-NGO team first, and also include a practice session before integrating the OHAP into local village groups.

The greatest improvement observed in both dentitions was from Lavaliee village, which was trained by the CP group. This could be attributable to all children attending school and in the learning mind-set, in addition to the peer-to-peer influence being more effective than with the WSHG group. The CFCD team also had to assist the CP group during the OHAP, but the village participants of parents and children did indeed pay attention and participate, as discussed in section 7.3.3. The CFCD groups showed

the greatest improvement for the reduction of visible calculus in the village of Kuradpada (Table 5.5).

All groups were effective in delivering the OHAP, and had positive results, although a collective collaboration of every ETG would be recommended as the most effective in influencing a positive sustainable change in oral health practices for these populations.

7.4.2 Strengths, Limitations and Suggestions for the Test Groups

This study was carried out during the second year of the HCDI project within the tribal clusters. Trainings of this size were just being introduced to the villagers, and the concepts of oral care were new to all those involved. Despite this, the NGO teams were highly motivated and professionally organized amidst all aspects of this study. Strengths of the study show the willingness and cooperation of both the CFCD teams and the ETGs directly influenced the success of the OHAP within their projects. However, limitations have been observed, and suggestions for improvement for future research will be recommended in the next section.

7.4.3 Limitations and Suggestions for the WSHG

Three women from sixteen villages were invited to attend the OHAP course. Twenty-three arrived on time, three were late to attend the course, four brought babies, and one brought four children aged 10-15. The remainder of the invited women, who did not attend, were working in the fields, since it was rice harvest season. Only five

participants could read and write, and therefore most of them did not know what to do with a pen that was provided for filling out the questionnaires, and looked perplexed and confused regarding to what to do exactly. Researchers were not aware of this challenge before the study began. Therefore, the questions were read aloud, and the CFCD team assisted with the completion of the questionnaires via verbal translation and writing answers on the questionnaire. Following the questionnaire part of the programme, the OHAP course was presented by two dental professionals via an interpreter, the latter being one of the NGO team leaders.

Notwithstanding, it was indeed a challenge to persuade the women to stand up or stand out and participate in front of others. They were reluctant, at first, to answer questions out loud in front of others, and more importantly, strangers, since most had not met during a previous community development course. Moreover, they were shy and reserved until the NGO team encouraged them to participate. Since active participation in courses is a new concept in early community development, women involved do not actively volunteer to be a leader or demonstrate a task at this stage of development. Furthermore, most women cannot read nor write the local language. After a few years being involved and understanding how the NGO community development project works and functions, and when a learning concept has been accepted, this might be considered a more acceptable time to introduce an OHAP to the local NGO programmes.

Suggestions for improvement:

- Identify the key woman or women in leadership positions from each village, as they would be the principle motivational figures for others.
- Use smaller groups if possible, perhaps only per village for trainings and not large groups, if logistics and time allows.
- Ask the NGO for the most effective manner to disseminate the information and question the participants.
- Provide the NGOs with material, education packets, and identify key points of measurable information in advance.
- Create a local team of trainers to present the OHAP in individual villages rather than in large groups.
- Establish smaller, more specific groups such as new mothers or health worker groups, a grandparents group, etc.
- Encourage smaller groups involving their children so that parents may be actively shown how to care for their child's teeth during the different developmental stages of growth.

Furthermore, during tooth brushing demonstrations, many women were reluctant to practice this task since they had learned or heard that they required toothpaste to brush. Since fluoride toothpaste is essential for oral health, especially in children, the concept of dry brushing for practice was new, and is therefore required to be explained further to both trainers and participants of the OHAP.

7.4.4 Strengths, Limitations and Suggestions of CP (13-14 year olds)

Five children between the ages of 12-15, from each of the 16 villages were invited to participate. One hundred children arrived with forty-three of them between the ages of 10-11. The groups were split into age categories. The older group, aged 12-15, were accepted to attend the OHAP. The younger group also participated in a separate presentation, but results were not assessed, since this was not the target group for the OHAP. All older children were in school, and could read and write the local language; indeed, some understood a small amount of English. The challenge for the CP group was holding attention spans and limiting distractions amongst a large group. Some wanted to simply play, and hence disturbed those wanting to learn.

Suggestions for improvement:

- Limit group sizes to specific ages and less than thirty participants per group.
- Seek and identify the children who demonstrate leadership abilities to the trained team.
- Utilise a classroom setting rather than a large open 'hall' type area for improved control.
- Have children participate in general, questioning rather than asking direct opinions individually to the child: this promotes open discussions.
- Develop educational methodologies similar to a school-participation style.
- Keep the OHAP short and simple, with interactions and questioning.

- If taking questionnaires, read questions to the group first, and subsequently have them read on their own and accept answers.

It should also be considered that older children do not have as much authority as adults do, and so older children should have some level of assistance from an adult or authority figure, at least primarily, when leading such a programme.

7.4.5 Suggested Improvements to the management of the OHAP course

Since this study demonstrated successful results in utilising non-dental groups for promoting and executing an oral health programme, recommendations for improvements and suggestions are listed below:

- Commence with an open discussion of recognised oral disease problems and concerns within the individual communities.
- Ask what daily habits are being done and why.
- Ask what concerns they have for the children who have dental pain, and what consequences have they observed from this dental problem.
- Keep OHAP presentations to less than 30 minutes.
- Offer Q & A sessions during and after the presentation.
- Encourage open questions and discussion throughout the presentation.
- Demonstrate tooth brushing in smaller groups.
- Demonstrate to parents how to brush smaller children's teeth utilising their own child.

7.5 Strengths, Limitations and Suggestions of the NGO- CFCD

The CFCD team consisted of ten staff members, each able to read and write the local language. Half could read and write English, whilst the other half spoke broken English only. One of the greatest challenges was with NGO duties and priorities within the normal scope of community development. If the OHAP programme was provided too early within a developmental strategy, then its sustainability may be limited. The time and energy required to organise and implement such an OHAP will be drastically cut and jeopardize the effectiveness of the OHAP. Integrations of such programmes could be more effective and openly accepted after self-help, children's rights, and other community groups have formed and had several years of development and growth prior to establishing such an OHAP course. This could increase acceptance, involve more members of the community, (i.e. fathers and grandfathers), encourage active involvement in their children's development and health, provide a greater level of protection against oral disease, and create a continued sustainability. Hence, future studies on the appropriate time to integrate such programmes into NGO developmental projects are recommended.

7.6 Community Developmental Issues, Concerns and Challenges

7.6.1 NGO involvement outcomes

The members of the CFCD team were exceedingly efficient and organised, and executed the child screenings to a very high standard. They provided all materials and equipment needed, which were not easily transported from the UK. They collected

signed or 'thumb printed' consent forms, distributed the questionnaires to the parents, and documented every child participating in the OHAP.

One of the main strengths and advantages this present study has observed throughout the research design and implementation of the programme is the importance of working closely with NGO teams. The ability to plan the programme in advance can enhance the achievement of successful results. Since most villagers had never been exposed to Western subjects, and nor had their children previously participated in a dental screening, curiosity was high, but the programme was, however, openly welcomed. The advantages of utilising already established NGO teams who have spent years developing an open and trusted relationship with these tribal people, provided ready access to these populations. It also removed the possible challenging issues such as crowd control, children's fear, scepticism of parents not understanding the value of such a programme, and fear that the children would be harmed.

Indeed, rural communities are very tight-knit and protective of their children.

Establishing trust within these communities is the first and foremost challenge for new NGO developmental project leaders, and can take years to achieve. Villagers can be reluctant to interact with newcomers and guard against being taken advantage of, since many have been in previous years. This bond is not something to jeopardize, and therefore connecting into an existing infrastructure gains trust within these populations.^{107,110,112}

7.6.2 Durability, Sustainability and continued OHAP

This study has shown that not only can local non-dental training groups within NGO projects implement an oral health promotion and awareness programme, such a programme may also provide sustainable outcomes of dental disease reductions, together with improved oral hygiene habits of children within these populations.

This was apparent during the first volunteer visit, before the vision to research the topic, and determine if it could be monitored, arose. In each of the mission hospitals visited, the Director of the hospital was informed about the profession of dental hygiene, and how it serves to support and educate prevention and awareness of the oral health link to general health. Directors involved quickly understood the viability of the information and asked us to present the information to the staff doctors. The self-designed presentation, “Your mouth is the door to your body” was enthusiastically received so much, that we were asked to further present to the entire nursing staff and later the nursing students. One year later, a two-day ‘hands-on’ course for the dental teams from all eight mission hospitals in southern India, under the support of KNH, followed. This was the first sign that the material, which was new to them, was seen as necessary to learn in order to educate their patients and families.

Upon introduction of the DHFI teams for follow up after the OHP course in 2011, it was observed that many of the hostels had installed sinks, mirrors, and brushing

stations for the children, in order to facilitate daily oral care. Some schools even had the younger children supervised by older ones.

Another example not measured but witnessed as an observed outcome of the pre-study needs assessment was the involvement of a taxi driver. He was with the team for a week as they gathered screening data. At the end of the screenings, we gave every child a toothbrush and toothpaste, along with toothbrushing instructions. During the last village of the week, the taxi driver, having heard the oral hygiene instructions multiple times, took it upon himself to pass out all of the toothbrushes and toothpaste to the children and proceeded to give the toothbrushing instructions on his own accord. The research team was still acquiring data, yet he was excited and passionate about participating and passing on the knowledge he had received during the week.

Finally, after the OHP course for the hostel staff, one of the participants presented an article from the local paper discussing the link between diabetes and periodontal disease. He reported that he would have never read the article or even noticed it before the course. Subsequently, it was one of the first articles he read when he opened the paper, thanks to his new found awareness of the importance of oral health.

Not only do these examples support the possible longevity of the OHAP and significance in the sustainability of such programmes, the results in Chapter 5 clearly

show an actual reduction of dental decay within a one year time span, which validates the sustainability aspect of this study.

7.6.3 Community Development Transformations and Challenges

Rural development, as described by Wikipedia is, “the process of improving the quality of life and economic well-being of people living in relatively isolated and sparsely populated areas.”¹¹² The premises for sustainable development are economic, environmental, social, and political. For many years, a ‘top-down’ approach process has been initiated, and involves policy makers, professional leaders, and external organisations. These investors evaluate, analyse, plan, and implement programmes by influencing and instructing the communities on exactly what to change, and how to accomplish such modifications. This concept focuses on the optimism that communities will follow external leadership and change perspectives, behaviours, and standards of living. Since this approach might be appropriate for some areas, it might not be effective in some others.¹¹³

In the past decade, KNH has been encouraging and partnering with Community Based Organisations (CBO) moving towards a Self-Help Group (SHG) approach, defined as “the approach to development which promotes the enjoyment of human rights for all vulnerable and marginalised people, especially the poorest of the poor”.^{114,115} Core strategies of ‘rights-based’ approaches and SHGs enable locals to realise and reclaim rights through self-empowerment, ownership, and decision making principles.^{109,110} Women and children are the first focus groups, followed by family and community

groups. Indeed, 'needs-based' issues such as Health, Education, and Nutrition are the primary concerns. KNH provides CBOs with the tools, teaching aids, and funding for this sustainable 'self-help' development. The challenges within these underserved populations are to create a self-reliant, decision-making, and self-motivated community which is driven towards the creation of positive changes for improvements in their lives, and the lives of their children, thus achieving long-term sustainability.

KNH, together with its partners in India, have taken a newer "participatory approach" to community development within the past few years. Instead of a more traditional 'top-down' approach, as practiced for over 50 years, more of a 'self-help' approach is being implemented. Rural communities in need of enhancement are cautiously approached by the local NGOs, focusing first on reaching out to women. Once the women have accepted 'assistance', groups are created according to their needs; as an assessment is prepared, from a 'need' perspective. A developmental and sustainable evaluation is at first completed by the NGO, but more importantly, the women's' self-help groups are encouraged to approach issues from their perceived requirements. NGO's are primarily listening to local issues and requirements, and developing programmes specifically to fit the requests of the villagers. This approach is more of a 'grass-roots' methodology, which enhances motivation towards self-help and implementation.¹¹³⁻¹¹⁵

This study used a variation of a 'grass-roots' approach by utilising local non-dental groups for the promotion and awareness of oral health, instead of traditional 'top-down' and school-based methods. Results have statistically proven that within a one-year period, and following an OHAP course delivered by non-dental ETGs, oral health changes such as reductions of visible decay and visible calculus in primary and permanent teeth could be observed in the screened children. Motivation, active involvement of local groups and community members, empowerment, and skill-set training taught via coached and trained non-dental professionals can achieve improved and sustainable oral health maintenance for children of these poorer populations.

7.7 Suggestions and Recommendations for Future OHAP with NGO collaborations

KNH has reported that their main focus regarding working with developing communities is 'education and early intervention', pertaining to the "Promotion of child rights to protection, provision and participation"¹⁰⁹ for poorer populations. KNH serves to teach life skills about children's basic rights to life, health, shelter and nutrition. Sustainable programmes for healthcare, security, and access to education and vocational training are taught, and therefore these poorer populations can offer their children an improved life.¹¹⁴ Collaborating with KNH and other NGOs served to be a viable option in the promotion of oral health in developing communities, and this has been suggested many times in various studies.¹¹⁶⁻¹¹⁹

The challenges that arise in Oral Health Promotion for children in developing communities are listed below.

The Problem:

- High levels of decay in primary and adult first molars
- Increased sugar intake
- Missing teeth, malocclusion, retained primary teeth
- Pain
- Heavy plaque and food debris
- Poor oral hygiene

Potential reasons for the problem:

- Limited dental knowledge or value placed on oral health for children
- Poor oral health habits
- Local customs and beliefs blocking access to active treatments
- Availability and easy access of sugar products such as hard sweets and sugary drinks
- Sweets and sweet tea regarded as sources of food
- Sweets and sugary foods provided as rewards or 'pacifiers' to children

Other priorities required for community-development:

- Sources of food
- Clean water
- Shelter
- Safety for children
- Livelihoods and sources of incomes

- Access to education and schools for children
- Healthcare and local disease prevention
- Women and children's rights and protection

A combination strategy for oral health awareness and promotion within developing communities could be more effective than a single 'top-down' approach. The OHET could comprise dental professionals including dental hygienists, dental therapists, dental students, and dentists either locally-based or as volunteers from other countries, working in partnerships with dental charities and NGOs. Linking with local charitable dental groups for on-going maintenance and access to dental services, these populations would also be provided with a longer sustainability of oral health.

7.7.1 Future Research Recommendations

Other suggestions for replication of this study (as noted above), and further research work involving established NGO teams, are as follows:

- Collaborations with NGOs who have established long-term developmental programmes.
- To seek and recruit NGOs who exert a direct influence, and also have sustainable reputations in their local areas.
- Collaborations with local dental charities and volunteer dental students.

- Integration of the OHAP during the healthcare promotion component of the development programmes, perhaps at the 4th or 5th year of the developmental project.
- Introduction of an OHAP to the medical trainers so that relevant information maybe passed onto local teams.
- Introduction of focus programmes as ‘preventative’ concepts in order to avoid the ‘pain and repair’ consequences.
- Join with local or volunteer groups of dental hygienists, dental therapists and dental students eager to offer knowledge and skills for the underserved populations.
- Collaborations with local NGOs for determining the most effective time to integrate OHAPs into health programmes.

7.8 Impact of Study and Future Recommendations

Oral health education, awareness and promotion are on-going challenges globally.

They can be especially challenging in developing communities, since dental health is not a priority when compared to the major essential requirements for clean water, nutrition, sanitation, and also the prevention of communicable diseases, to name but a few.

NGO’s have successfully established practical educational programs for community development, which provide information and skills for sustainability programmes, i.e.

those involving the creation of improved livelihoods, health issues and disease

prevention, sanitation and clean water establishment, community governmental groups,

children’s and women’s rights, access to education for children, and most of all nutrition

and sources of healthy food, and access to healthcare. Working with these groups can be beneficial, effective, and rewarding.

7.8.1 Financial Impact

There are thousands of NGOs worldwide, investing generous amounts of money and time into these underserved populations. In a recent report by the Indian Central Bureau of Investigation (CBI), there are over 33,000 registered NGOs with the Foreign Contribution Regulations Act (FCRA) in India. They estimate that the actual count is likely to be much higher including non-registered organisations.⁸³ The Indian Ministry of Home Affairs data has published that 2015-2016 has experienced an estimated influx of over \$2.6 Billion in donations from foreign donors.^{83,120,121} Backing and funding from these NGOs, provide essential assistance to support programmes which address issues in the environment such as safe drinking water, tribal rehabilitation, soil and water conservation, crop cultivation and irrigation. Youth and educational access, women's rights and empowerment, micro-enterprise and children's rights are all vital concerns within these poorer populations, which are also included within community development activities. Various areas of concentration are health, maternity and safe birthing methods, HIV and Aids prevention, immunizations, childcare and child protection, and health access and medical care. Notwithstanding, there is very limited support and documentation, which includes oral health as an essential component of the health programmes and NGO projects.

OHAPs operating at a 'grass-roots' level with peer-to-peer influence has been suggested, although this has not been fully researched until now. This exploratory research study reiterates the importance of integrating oral health as a vital part of overall healthcare, instead of regarding it as a final, less important priority, and instituted only once pain has arisen. Although financial statistics were not a major aim of this study nor specifically documented, some observations are presented here to show the important added impact and cost/benefit outcomes achieved.

The cost of running this study was relatively low. The research team consisted of 3-4 volunteers who paid for their own flights and visas. KNH paid for all logistics including local transportation and accommodations. Karunya Trust and HCDI provided food for the volunteers, and toothbrushes and toothpaste for the children, and participants of the OHAP. The ETGs were local groups living in the villages or NGO employees themselves, so no extra funds were required for these groups. An estimated total for an entire week of OHAP including screenings and treatment of all who required it, amounted to less than \$1,000.00, excluding flights and visas. Not only was this affordable, working with local NGOs lessened the requirement for Governmental spending, which is scarcely available nor stipulated in the National Health Budget, as noted previously.⁶⁰⁻⁶²

Moreover, working with NGOs for oral health awareness and promotion provides a cost-effective alternative. It also recognised and supported the on-going works of local

NGOs backed by foreign support, and may facilitate the attraction of an increased level of donations to these organisations.

This study serves as an alternative method and strategy for oral health promotion, in addition to school-based and hospital-based programmes. It provides another platform for Oral Health Promotion in developing countries, and also a new area of research to explore, involving local non-dental groups, local NGOs, and community-based groups with dental clinicians serving as volunteers. A programme such as that performed in this study provides educational and training materials, plus the know-how in setting up such projects for both the professional training teams and local non-dental groups.

7.8.2 Partnerships and Collaborations

Partnering with established NGOs not only promotes oral health, it also provides a more affordable way to promote OHAP through the interactive collaboration of various organisations. These could also serve as possibilities for future research involving the following subjects.

- Cost effectiveness: NGOs providing funding through various corporate and private donations.
- Dental Charity groups providing dental professionals as OH Educators and primary trainers.
- Opening access to the utilisation of such groups for OHE programs, and also those with a limited budget.

- Provides NGOs with another aspect to add into their general health education, as indeed it does for local healthcare workers.
- Offers volunteers a chance to “give back” and donate time and knowledge for a good cause and be part of a promotion for oral health globally.
- Provides a long-term sustainability, since NGO groups can work 5-9 years with community development programmes, and the team are local members of nearby villages and the developmental village itself.
- Offers a platform for collaborations between NGOs, charities, and local groups for OHAP.

Finally, it crosses sectors and disciplines through combining the efforts of professional and local groups aiming towards a common goal of ‘helping them to help themselves’.

8. Concluding Comments

Oral diseases continue to be a worldwide epidemic, particularly in developing countries. Children are at the highest risk for dental diseases, and most children in these populations have never seen a toothbrush, let alone used one before. Oral health programmes can be time-intensive and costly to run and many countries do not allocate governmental budgets for oral health spending. Many private NGOs have implemented health topics within community-based developmental programmes, however oral disease prevention is not included nor is it a high priority. There is a lack of knowledge, information, resources and training programmes available for these groups on how to promote oral health within underserved populations.

Local NGO groups have established and recognised programmes and strategies for sustainable community developments. Indeed, they have created solid functioning infrastructures within communities, improved transportation and logistical resources for reaching these populations, and also have financial backing through donations and sponsorships. The collaboration and utilisation of non-dental NGO teams and local participatory groups from a 'grass-roots' level have proven to be viable partners for disseminating information and activities for oral health awareness and promotional programmes within these populations.

The exploratory research described in this thesis has shown evidence for comprehension of the OHAP course and its effectiveness. Screening data has shown signs of less decay in molar teeth after one year, and an improvement in daily oral habits. The evidence also revealed that there could be immediate improvements through introducing a structured and understandable oral health programme utilising non-dental NGO and local participatory groups. Alliances with these groups are not only beneficial from 'peer-to-peer' influence and established trust perspectives, but also from a financial one.

This creates a compelling case for further research utilising these groups for oral health awareness and promotion in developing communities.

9. References

1. Carlsson, P. et al. (1998). School-based primary preventive programme for children. Affordable toothpaste as a component in primary oral healthcare. Experiences from a field trial in Kalimantan Barat, Indonesia. Geneva: WHO.
2. Monse, B., Benzian, H. et al. (2013). The Fit for School Health Outcome Study - a longitudinal survey to assess health impacts of an integrated school health programme in the Philippines. W. BMC Public Health, Mar 21; 13:256.
3. Milsom, K. et al. (2006). The effectiveness of school dental screening: a cluster-randomized control trial. J Dent Res, 924-8.
4. Hebbal, M., Nagarajappa, R. (2005). Does school-based dental screening for children increase follow-up treatment at dental school clinics? J Dent Educ. Mar;69(3):382-6.
5. Pine, C.M. et al. (2000). An intervention programme to establish regular tooth brushing: understanding parents' beliefs and motivating children. Int Dent J, Suppl Creating A Successful, 312-23.
6. Viswanathan, M. et al. (2005). Community- Based Participatory Research: Assessing the Evidence: Summary. 2004 Aug. In: AHRQ Evidence Report Summaries. Rockville (MD): Agency for Healthcare Research and Quality (US);1998-2005.99.
7. WHO Dental Diseases and Oral Health Fact Sheet. (2003: Update 2012).
8. Bagramian, R.A. et al. (2009). The global increase in dental caries. A pending public health crisis. Am J Dent, Feb;22(1):3-8.
9. Sheiham, A., Williams, D.M. et al. (2015). Billions with oral disease: A global health crisis-a call to action. J Am Dent Assoc. Dec, 146(12):861-4.
10. Tanzer, J. (2001). The microbiology of primary dental caries in humans. Journal of Dent Education, 65(10):1028-1037.
11. Socransky, S.S. (1970). Relationship of bacteria to the etiology of periodontal disease. Journal of dental research, 49(2):203-222.
12. Çolak, H. et al. (2013). Early childhood caries update: A review of causes, diagnoses, and treatments. Journal of Natural Science, Biology, and Medicine, 4(1):29-38.

13. Selwitz, R.H., Ismail, A.I., Pitts, N.B. (2007). Dental caries. *The Lancet*, 369(9555):51-59.
14. Trowbridge, H.O. (1981). Pathogenesis of pulpitis resulting from dental caries. *Journal of Endodontics*, 7(2):52-60.
15. Johnston, L., Vieira, AR. (2014). Caries experience and overall health status. *Oral Health Prev Dent*, 12(2):163-70.
16. Fejerskov, O. (1997). Concepts of dental caries and their consequences for understanding the disease. *Community dentistry and oral epidemiology*, 25(1):5-12.
17. Nicolau, B., Marcenes, et al. (2003). A life course approach to assessing causes of dental caries experience: the relationship between biological, behavioural, socio-economic and psychological conditions and caries in adolescents. *Caries research*, 37(5):319-326.
18. Gerritsen, AE., Allen, PF. et al. (2010). Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health Qual Life Outcomes*, 8:126.
19. Moynihan, P., Petersen, P.E. (2004). Diet, nutrition and the prevention of dental diseases. *Public Health Nutr.* Feb;7(1A):201-26.
20. Holt, K., Barzel, R. (2013). *Oral Health and Learning: When Children's Oral Health Suffers, So Does Their Ability to Learn*. 3rd ed. Washington, DC: National Maternal and Child Oral Health Resource Center; May 20, 2015.
21. Acs, G., Lodolini, G. et al. (1992). Effect of nursing caries on body weight in a pediatric population. *Pediatr Dent*, 14:302-5.
22. Tsakos, G., Allen, P.F. et al. (2012). Interpreting oral health-related quality of life data. *Community Dent Oral Epidemiol*, 40(3):193-200.
23. Marsh, P.D., Bradshaw, D.J. (1995). Dental plaque as a biofilm. *J Ind Microbiol.* Sept;15(3):169-75.
24. Bernimoulin, J.P. (2003). Recent concepts in plaque formation. *J Clin Perio.* 30 Suppl 5:7-9.
25. Wolff, M. S., Larson, C. (2009). The cardiogenic dental biofilm: good, bad or just something to control?. *Braz, Oral Res*, pp.31-38.

26. Jakubovics, N.S, Kolenbrander, P.E. (2010). The road to ruin: the formation of disease-associated oral biofilms. *Oral Dis.* Nov;16(8):729-39.
27. Kina, J.R., Suzuki, Y.U., et al. (2016). Non-Inflammatory Destructive Periodontal Disease. *The Open Dent J.* 10, 50-57.
28. Larsen, T. Fiehn, N.E. (2017). Dental Biofilm infections-an update. *APMIS* April;125(4): 376-384.
29. Theilade, E. (1986). The non-specific theory in microbial etiology of inflammatory periodontal diseases. *Journal of clinical periodontology*, 13(10):905-911.
30. Socransky, S.S., Haffajee, A.D. (1992). The bacterial etiology of destructive periodontal disease: current concepts. *J of Periodontology*, 63(4s):322-331.
31. Petersen, P.E. et al. (2005). The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*, 83(9):661-669.
32. Tonetti, M. S. (1998). Cigarette smoking and periodontal diseases: etiology and management of disease. *Annals of Periodontology*, 3(1):88-101.
33. Humphrey, L. et al. (2008). Periodontal disease and coronary heart disease incidence: a systematic review and meta-analysis. *Journal of General Internal Medicine*, 23(12):2079.
34. Demmer, R.T., Jacobs, D.R. et al. (2008). Periodontal disease and incident type 2 diabetes. *Diabetes care*, 31(7):1373-1379.
35. Bingham, C.O., Moni, M. (2013). Periodontal disease and rheumatoid arthritis: the evidence accumulates for complex pathobiologic interactions. *Current opinion in rheumatology*. 25(3):345-353.
36. Listgarten, M.A. (1980). Periodontal probing; what does it mean? *J Clin Periodontol.* June;7(3):165-76.
37. Loesche, W.J., Grossmann, N.S. (2001). Periodontal Disease as a Specific, Albeit Chronic, Infection: Diagnosis and Treatment. *Clin Micro Rev*, 14(4): 727-752
38. Jin, Y., Yip, HK. (2002). Supragingival calculus: formation and control. *Crit Rev Oral Bio Med.* 13(5):426-41.

39. Calabrese, N. et al. (2007). Identification of *Actinobacillus actinomycetemcomitans*, *Treponema denticola* and *Porphyromonas gingivalis* within human dental calculus: a pilot investigation. *J Int Perio.* Oct;9(4):118-28.
40. Baelum, V. et al. (2007). A global perspective on changed in the burden of caries and periodontitis: implications for dentistry. *J oral Rehabil.* Dec;3(12): 872-906 discussion 940.
41. Shaju, J.P., Zade, R.M., et al. (2011). Prevalence of periodontitis in the Indian population: A literature review. *Journal of Indian Society of Periodontology*, 15(1):29–34.
42. Gambhir, R.S., Brar, P. et al. (2013). Utilization of dental care: An Indian outlook. *Journal of Natural Science, Biology, and Medicine*, 4(2):292–297.
43. White, D. (1997). Dental calculus: recent insights into occurrence, formation, prevention, removal and oral health effects of supragingival and subgingival deposits. *Eur J Oral Sci.* Oct;105(5Pt 2):508-522.
44. Kumar, S. et al. (2015). A Profilometric Study to Assess the Role of Toothbrush and Toothpaste in Abrasion Process. *J Dent.* 16(2Suppl):267-273.
45. Keyes, P.H., Rams, T.E. (2016). Dental calculus arrest of dental caries. *J Oral Bio (Northborough, Mass)*, 3(1):4.
46. Twetman, S. (2015). The evidence base for professional and self-care prevention: caries, erosion and sensitivity. *BMC Oral Health*, 15(Suppl 1), S4.
47. Porter, S.R., Scully, C. (2006). Oral malodour (halitosis). *BMJ British Medical Journal*, 333(7569):632-635.
48. Ratcliff, P. A., & Johnson, P. W. (1999). The relationship between oral malodor, gingivitis, and periodontitis. A review. *J. Perio.* 70(5): 485-489
49. Khurram, (2007). Evolution of the toothbrush, Library of Congress online, Gargles, August 6.
50. Singh, SV., Tripathi, A. et al. (2012). Prevalence of dental myths, oral hygiene methods and tobacco habits in an ageing North Indian rural population. *Gerodontology*. Jun;29(2):e53-6.

51. Iheozor-Ejiofor, Z. et al. (2015). Water fluoridation for the prevention of dental caries. *Cochrane Database of Systematic Reviews*, Issue 6. Art. No.: CD010856.
52. Marinho, V., Higgins, J. (2004). Combinations of topical fluoride (toothpastes, mouthrinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and adolescents. *Cochrane Database of Systematic Reviews*, Issue 1. Art. No.: CD002781.
53. Jain, N., et al (2012). Oral hygiene-awareness and practice among patients attending OPD at Vyas Dental College and Hospital, Jodhpur. *Journal of Indian Society of Periodontology*, 16(4):524–528.
54. Bloor, V. A., et al (2014). Unconventional Dentistry in India – An Insight into the Traditional Methods. *Journal of Traditional and Complementary Medicine*, 4(3):153–158.
55. Krisnamurthy, M.S. et al. (2013). *Charaka Samhita Sutrasthana*. Ayurvedic dietetics, Chapter 5: *Matrashiteeya Adhyaya*, i.e. Quantitative of Dietetics.
56. U.S. Gov Print Office. (2010). Department of Health and Human Services (US) Healthy People: midcourse review on oral health. Washington: Dec.
57. Office of the Surgeon General (US). (2000). Department of Health and Human Services (US) Oral health in America. A report of the Surgeon General. Rockville (MD):HHS.
58. United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*, custom data acquired via website.
59. India Census 2011. (2011). Provisional Population Totals, Ministry of Home Affairs, 31 March.
60. Bloom, DE. (2011). Population Dynamics in India and Implications for Economic Growth. PGDA Working Paper No. 65.
61. World Bank Development Report. (2015). A Global Count of the Extreme Poor in 2012: Data Issues, Methodology and Initial Results. Policy Research Working Paper 7432, WHO. Oral Health. Fact sheet no. 318. April 2012.
62. Kothia, N. R., Bommireddy, V. S. et al. (2015). Assessment of the Status of National Oral Health Policy in India. *International Journal of Health Policy and Management*, 4(9):575–581.

63. Petersen, PE. (2003). The World Oral Health Report continuous improvement of oral health in the 21st century: the approach of the WHO Global Oral Health Program. *Community Dent Oral Epidemiol*, 31(suppl 1):3-23.
64. Kim, J., Amar, S. (2006). Periodontal disease and systemic conditions: a bidirectional relationship. *Odontology / the Society of the Nippon Dental Uni*. September; 94(1): 10–21.
65. Deen, J.L, et al. (1999). Injuries and non-communicable diseases: emerging health problems of children in developing countries. *Bulletin of the World Health Organ*, 77(6):518-24
66. Amaliya, et al. (2007). Java project on periodontal diseases: the relationship between vitamin C and the severity of periodontitis. *J Clin Peridontol*, 34(4):299-304.
67. Lehman, J.S., Bruce, A.J., Rogers, R. (2006). Atrophic glossitis from vitamin B12 deficiency: a case misdiagnosed as burning mouth disorder. *J Periodontol*, 77(12):2090-2.
68. Sgan-Cohen, H.D., Mann, J. (2007). Health, oral health and poverty. *J Am Dent Assoc*, 138;1437-1442.
69. López, N.J. et al. (2005). Periodontal therapy reduces the rate of preterm low birth weight in women with pregnancy- associated gingivitis. *J Periodontol*, 76(11 suppl):2144-53.
70. Jansson, L. et al. (2002). Relationship between oral health and mortality rate. *J Clin Periodontol*, 29(11):1029-34.
71. Singh, R.B., Singh, V. et al. (2005). Social class and all- cause mortality in an urban population of North India. *Acta Cardiol*, 60(6):611-7.
72. Dhar, V., Bhatnagar, M. (2009). Dental caries and treatment needs of children (6-10 years) in rural Udaipur, Rajasthan. *Indian J Dent Res*, 20:256-60.
73. Mahesh Kumar, P. et al. (2005). Oral health status of 5 years and 12 years school going children in Chennai city - An epidemiological study. *J Indian Soc Pedod Prev Dent*, 23:17-22.
74. Sudha, P. et al. (2005). Prevalence of dental caries among 5-13-year-old children of Mangalore city. *J Indian Soc Pedod Prev Dent*, 23:74-9.

75. Saravanan, S. et al. (2008). Caries prevalence and treatment needs of rural school children in Chidambaram Taluk, Tamil Nadu, South India. *Indian J Dent Res*, 19:186-90.
76. Tandon, S. (2004). Challenges to the oral health workforce in India. *J Dent Educ*, 68(7 Suppl):28–33.
77. Elangovan, S. et al. (2010). Indian Dental Education in the New Millennium: Challenges and Opportunities. *J Dental Education*, (9)Vol.74,9:1011-16.
78. Curnow, M.M.T., Pine, C.M. et al. (2002). Randomised controlled trial of the efficacy of supervised tooth brushing in high-caries-risk children. *Caries Res*, 36:294–300.
79. Chhabra, N., Chhabra, A. (2012). Parental knowledge, attitudes and cultural beliefs regarding oral health and dental care of preschool children in an Indian population: a quantitative study. *Eur Arch Paediatr Dent*, Apr;13(2):76-82.
80. Rogers, JG. (2011). Evidence-based oral health promotion resource. Prevention and Population Health Branch, Gov of Victoria, Dept. of Health, Melbourne.
81. Petersen, PE. (2008). World Health Organization global policy for improvement of oral health. World Health Assembly 2007. *Int Dent J* 58:115-121.
82. Pitts, N., Amaechi, B. et al (2011). Global oral health inequalities: dental caries task group research agenda. *Adv Dent Res*, May;23(2):211-20.
83. Singh, V. (2017). Foreign funds surge under NDA rule. *The Hindu*, article no.17330939 Feb.
84. World Health Organization. (2013). *Oral Health Surveys: Basic methods*. 5th edition. Geneva: WHO.
85. Ripa, L. (1988). Nursing caries: a comprehensive review. *Ped. Dent*, Vol.10, Nr.4: 268-282
86. Prochaska, J.O., Redding, C.A., & Evers, K. (2002). *The Transtheoretical Model and Stages of Change*. *Health Behavior and Health Education: Theory, Research, and Practice* (3rd Ed.). San Francisco, CA: Jossey-Bass, Inc.

87. Chambers, R. (July 1994). "The origins and practice of participatory rural appraisal" (PDF). *World Development*. 22 (7): 953–969.
88. Chambers, R. (April 1981). "Rapid rural appraisal: rationale and repertoire" (PDF). *Public Administration and Development*. 1 (2): 95–106.
89. Chambers, R. (1984). *Rural development: putting the last first*. London; New York: Longman. ISBN 0582644437
90. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 50 (2):179-211.
91. Frencken, J.E., Leal, S.C. (2012). Twenty-five-year atraumatic restorative treatment (ART) approach: a comprehensive overview. *Clin Oral Invest*, 16(5), 1337-1346.
92. Casamasimo, et al. (2009). Beyond the DMFT: The human and economic cost of early childhood caries. 140 *J. Am Dent. Ass.* N.650.
93. Maupomè, G. et al. (2010). Is there a relationship between asthma and dental caries?- a critical review of the literature. *J Am Dent. Assoc.* 141:1061-1074.
94. Jackson, S.L. et.al. (2011). Impact of poor oral health on children's school attendance and performance. *Am. J. Public Health*, 101(10):1900-1906.
95. Itzhak, B. (1995). Topical Review: Brain Abscess in Children: Microbiology and Management, 10 *J Child Neurology* 283.
96. de Silva, A.M. et al. (2016). Community-based population-level interventions for promoting child oral health. *Cochrane Database of Systematic Reviews*, Issue 9. Art. No.: CD009837.
97. Perla, R., et al. (2006). Caries prevalence and some associated factors in 6-9 year old school children in Campeche, Mexico. *Rev. Biomed*; 17:25-33.
98. Al-Meedani, L. A., Al-Dlaigan, Y. H. (2016). Prevalence of dental caries and associated social risk factors among preschool children in Riyadh, Saudi Arabia. *Pakistan Journal of Medical Sciences*, 32(2):452–456.
99. Choi, B. C., Pak, A. (2005). A catalog of Biases in questionnaires. *Prev Chronic Disease*, 2(1):A13.
100. Fejerskov, O. (2004). Changing paradigms in concepts on dental caries: consequences for oral health care. *Caries Res*, May-Jun;38(3):182-91.

101. Skeie, M.S. et al. (2004). Caries in primary teeth at 5 and 10 years of age: a longitudinal study. *Eur J Paediatr Dent*, Dec;5(4):194-202.
102. Leroy, R. (2003). Impact of caries experience in the deciduous molars on the emergence of the successors. *Eur J Oral Sci*, Apr;111(2):106-10.
103. Tanner, A.C. et al. (2016). Understanding Caries From the Oral Microbiome Perspective. *Journal of the California Dental Association* 44 (7):437-446.
104. Kundu, H., et al (2015). Dental Caries Scenario Among 5, 12 and 15-Year- old Children in India- A Retrospective Analysis. *Journal of Clinical and Diagnostic Research : JCDR*, 9(7):ZE01–ZE05
105. Sukhabogi, J. et al. (2014). Dental Fluorosis and Dental Caries Prevalence among 12 and 15-Year-Old School Children in Nalgonda District, Andhra Pradesh, India. *Annals of Medical and Health Sciences Research*, 4 (Suppl 3): S245–S252.
106. Kuriakose, S. et al. (2015). Prevalence of early childhood caries among preschool children in Trivandrum and its association with various risk factors. *Contemporary Clinical Dentistry*, 6(1):69–73.
107. Interagency report for The Hague Global Child Labour Conference. (2010). Geneva, ILO Understanding Children’s Work Programme: Joining forces against child labour.
108. Hazarika, G., Bedi, A.S. (2006). Child Work and Schooling Costs in Rural Northern India. IZA - Discussion Paper, May, No. 2136.
109. Bourgeois, D.M., Llodra, J.C. (2014). Global burden of dental condition among children in nine countries participating in an international oral health promotion programme, 2012–2013. *Int Dent J*, 64:27–34.
110. World Health Organization, Regional Office for Africa. (2016). Promoting Oral Health in Africa: prevention and control of oral diseases and noma as part of essential non-communicable disease interventions. WHO, Regional Office Africa.
111. Nakre, P.D., Harikiran, A.G. (2013). Effectiveness of oral health education programs: A systematic review. *J Int. Soc. Pre Community Dent*, Jul;3(2):103- 15
112. Overseas Development Institute. (2017). In Wikipedia, The Free Encyclopedia. Retrieved. April, 11, 2017.

113. Larrison, C.R. (2000). A Comparison of Top-down and Bottom-up Community Development Interventions in Rural Mexico: Practical and Theoretical Implications for Community Development programs. Ohio State Univ., College of Social Work.
114. KinderNothilfe. (2014). The Self-Help Group approach manual.
115. KinderNotHilfe.org. (2016). About us, Origin and Objectives
116. Aradhana, S., et al. (2016). Linkages between public and non-government sectors in healthcare: a case study from Uttar Pradesh, India. *Global Public Health*, Vol.8: Issue 10.
117. Wim van Palenstein-Helderman, E.L., Holmgren, C. (2003). Guidance for the planning, implementation and evaluation of oral health care demonstration projects for under-served populations. *Int Dent J.* Feb;53(1):19-25.
118. Wim van Palenstein-Helderman, et al. (2006). Implementation of a basic package of oral care: towards a reorientation of dental ngos and their volunteers. *Int Dent J.* Feb;56(1):44-8.
119. Knevel, R. (2010). Training rural women to improve access to oral health awareness programmes in remote villages in Nepal. *International Journal of Dental Hygiene*, 8:286–293.
120. Nayyar, S. (2014). Foreign funding of Indian NGOs. *Indian Def Rev*, Apr. 21.
121. Ministry of Home Affairs, (2017). FCRA Annual Report 2011-2012. Gov. of India, www.fcraonline.nic.in.

Appendix

Appendix 1 (a): Ethical Approval Document



HLS FREC Ref: 1327

10th March 2014

Tracey Lennemann
PhD Candidate

Dear Tracey,

Re: Ethics application – Sustainable delivery methods for 'Grass Roots' Oral Health Promotion (ref: 1327)

I am writing regarding your application for ethical approval for a research project titled to the above project. This project has been reviewed in accordance with the Operational Procedures for De Montfort University Faculty of Health and Life Sciences Research Ethics Committee. These procedures are available from the Faculty Research and Commercial Office upon your request.

I am pleased to inform you that ethical approval has been granted by Chair's Action for your application. This will be reported at the next Faculty Research Committee, which is being held on 19th June 2014.

Should there be any amendments to the research methods or persons involved with this project you must notify the Chair of the Faculty Research Ethics Committee immediately in writing. Serious or adverse events related to the conduct of the study need to be reported immediately to your Supervisor and the Chair of this Committee.

The Faculty Research Ethics Committee should be notified by e-mail to hlsfro@dmu.ac.uk when your research project has been completed.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Simon Oldroyd", with a long horizontal line extending to the right.

Dr Simon Oldroyd
Deputy Dean
Faculty of Health & Life Sciences

Faculty Research Ethics Committee
De Montfort University

Email: hlsfro@dmu.ac.uk

Web: <http://www.dmu.ac.uk/research/ethics-and-governance/faculty-specific-procedures/health-and-life-sciences-ethics-procedures.aspx>

Research & Commercial Development Office, Faculty of Health and Life Sciences

1.2b Edith Murphy House, The Gateway, Leicester LE1 5BH, T: (0116) 257 7765 E: hlsrcoenquiries@dmu.ac.uk

Appendix 1 (b): Consent form for parents of children participating in this study.



CONSENT FORM

Title of project: Oral Health Survey: How important are children's teeth?

Name of researcher: Tracey Lennemann

Please check all boxes if you agree

1. I confirm that I have been read the information sheet, Version 1, January 2014 and understand the research objectives. I have been able to ask questions and have had these answered to the best of my knowledge. ☐
2. I understand that my child's participation is voluntary and that I am free to withdraw my child at any time without giving any reason. ☐
3. I agree that non-identifiable (anonymised) research data may be published in journals or used for conference presentations. ☐
4. I understand that data collected during the research may be looked at by a supervisor from De Montfort University. I give permission for the supervisor to have access to my data. ☐
5. I agree to take part in this study ☐

Print name of participant

Date

Signature

Print name of person taking consent

Date

Signature

Consent form date of issue: Phase 1-2 January 2014
Consent form version number: Version 1

Consent Form Phase 1 & 2
Version 1. January 2014

Appendix 1 (c): Participant Information Sheet for this study.



PARTICIPANT INFORMATION SHEET

Title of Project: Oral Health Program: Improving Children's teeth.

Name of Investigators: Tracey Lennemann, Carole Brennan

Invitation to Participate:

We would like to know your opinion about children's teeth and oral health in your area. We would like to screen (look into your child's mouth) to determine if they have any dental disease problems. All information as to what why and what will be done will be explained to you. Ask us if there is anything that is not clear or if you would like more information. Participation is on a volunteer basis.

What is the research about?

This project is to gather information about the status of children's teeth in your area and the local opinion of taking care of them.

What does the research involve?

Part 1 is a 15-20 minute interview, (through a translator), in your village with questions focusing on your views of teeth and oral health. Part 2 is a screening of your child done by using a mouth mirror and light to look inside. The examiner will be wearing gloves and facemask for your child's protection.

What if my child does not want to take part?

If you or your child changes his/her mind about being looked at, they can leave at any time.

What are the possible disadvantages and risks of taking part?

There are no risks in taking part.

Will my taking part in this research be kept confidential?

All information that is collected about you and your child during the course of the research will be kept on a password-protected database and is strictly confidential. Your child's name will not be used and will be assigned an ID code number instead. Any identifiable information you may give will be removed and anonymous.

What will happen to the results of the research study?

With this information we will develop a preventative program to teach you how to care for your children's teeth and how to prevent future problems and pain. Some of these findings will be submitted for publication or used in a report.

Who has reviewed the study?

This study has been reviewed and approved by De Montfort University, Faculty of Health and Life Sciences Research Ethics Committee: Prof. Martin Grootveld.

Contact for Further Information

Tracey Lennemann: traceylennemann@hotmail.com (mobile: +44 7758 300 324)

Thank you for allowing your child to be screened and take part in this research.

Appendix 2: Raw data and % Responses for Questionnaire Questions

Question 2: How Important are Children's Teeth?				
	Very important	Kind of important	Not important	Totals
2014	166.0	34.0	0.0	200
%	83.0	17.0	0.0	100%
2015	167.0	80.0	2.0	249
%	67.1	32.1	0.8	100%

Question 4: When Should Children Clean their Teeth?					
	Morning	Before Sleep	Both	Not at all	Totals
2014	40.0	3.0	156.0	0.0	199
2014 %	20.1	1.5	78.4	0.0	100%
2015	9.0	1.0	239.0	0.0	249
2015 %	3.6	0.40	96.0	0.0	100%

Question 5: Is Cleaning Your Tongue More Important Than Cleaning Your Teeth?			
	Yes	No	Totals
2014	111.0	90.0	201
2014 %	55.2	44.8	100%
2015	229.0	19.0	248
2015 %	92.3	7.7	100%

Question 10: Would You Like to Learn More About Children's Teeth?			
	Yes	No	Totals
2014	186.0	11.0	197
2014 %	94.4	5.6	100%
2015	246.0	3.0	249
2015 %	98.8	1.2	100%

Question 13: Which is MORE Important?				
	Food	Shelter	Family	Totals
2014	142.0	4.0	9.0	155
2014 %	91.6	2.6	5.8	100%
2015	217.0	6.0	3.0	226
2015 %	96.0	2.7	1.3	100%

Question 14: Which is the LAST (Least) Important?				
	Sweets	Children's teeth	Cow	Totals
2014	146.0	48.0	5.0	199
2014 %	73.3	24.1	2.5	100%
2015	229.0	0.0	17.0	246
2015 %	93.1	0.0	6.9	100%

Appendix 3: Dental Decay Screening Data

(a)				
Overall decay percentages for all primary and permanent teeth from 2014 – 2015 and all primary molars (Nr. d and e) and first permanent molar (Nr.6).				
	Primary Teeth	Permanent Teeth	Primary Molars (d,e)	Permanent Molar (6's)
2014	69	55	66	54
2015	65	27	62	27
% Reduction	4	28	4	27

(b)				
Mean averages of decay in both primary and permanent teeth per child from 2014 – 2015.				
	2014	2014	2015	2015
	Primary	Permanent	Primary	Permanent
Mean	4.2	1.9	3.0	0.7
SD	4.0	2.0	3.0	1.0
SEM	0.2	0.1	0.2	0.0

Appendix 4: Comparisons of dental disease changes per village 2014 to 2015

(a)				
Village % changes of visible decay of primary teeth between 2014 & 2015.				
Primary teeth	Kudaran	Lavallee	Kuradpada	Chon
2014	62.0	60.5	71.6	82.1
2015	66.6	50.8	66.2	77.8
% Change	4.7	-9.6	-5.4	-4.2

(b)				
Percentage changes observed of visible decay of permanent teeth between 2014 & 2015 in each village sampled.				
Adult Teeth	Kudaran	Lavallee	Kuradpada	Chon
2014	52.4	53.1	62.5	51.2
2015	20.0	22.8	39.2	27.1
DT % Change	-32.4	-30.3	-23.3	-24.1

(c)				
Percentage change of visible decay of primary molars (d,e's) between 2014 and 2015.				
Primary Molars (d,e's)	Kudaran	Lavallee	Kuradpada	Chon
2014	62.0	56.8	67.0	79.8
2015	66.7	43.8	64.8	74.6
% Change	4.76	-13.0	-2.2	-5.2

(d)				
Percentage change of visible decay of permanent 6's between 2014 and 2015				
First Permanent Molar (6's)	Kudaran	Lavallee	Kuradpada	Chon
2014	53.9	53.0	59.0	50.0
2015	20.0	26.3	36.5	25.4
% Change in 6's	-34.0	-26.7	-22.6	-24.6

(e)						
Percentage of visible calculus change 2014 to 2015						
Visible Calculus	Kudaran	Lavallee	Kuradpada	Chon	Overall	SD
2014	11.1	24.6	27.2	26.1	22.3	7.5
2015	4.4	15.7	13.5	13.5	11.8	5.0
Calc. % change	-6.6	-8.9	-13.7	-12.6	-10.4	3.2

Available upon request only

Oral Health Awareness and Promotion

Training Program



by Tracey Lennemann RDH, BA

Supported by



1